SEP 1 1926

The Engineer.

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VOL. CXLII.—No. 3684] LONDON: FRIDAY EVENING, AUGUST 20, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

BOILERS, &c.

The Commissioners of His MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Wednesday, 1st September, 1926, for SUPPLY and DELIVERY of a LANCASHIRE BOILER and FEED PUMP at Rampton State Institution, near Retford, Notts.

Specification, forms for Tender, &c., may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3123

HEATING, &c.

The Commissioners of His MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 9th September, 1926, for HEATING and VENTILATING WORK at the New Public Offices, Whitehall, S.W.

Drawings, specification, a copy of the conditions and form of contract and forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3122

TO BUILDERS.

The Commissioners of His MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 3rd September, 1926, for the SUPPLY and ERECTION of a FUEL ECONOMISER, &c., at Rampton State Institution, near Retford, Notts.

Specification, a copy of the conditions and form of contract, forms for Tender, &c., may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3124

TO BUILDERS.

The Commissioners of His MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Wednesday, 1st September, 1926, for the SUPPLY and ERECTION of RUNWAYS, HOISTING and TRAVELLING GEAR at H.M. Stationery Office, Harrow.

Drawings, specification, a copy of the conditions and form of contract, and forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3126

TO BUILDERS.

The Commissioners of His MAJESTY'S WORKS, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 3rd September, 1926, for ACCELERATED LOW-PRESSURE HOT WATER HEATING, &c., at the "Strand" Telephone Exchange.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the Contracts Branch, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea (cheques payable to the Commissioners of H.M. Works, &c.). The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3125

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for:—

1. 46,000ft. STEEL WIRE ROPE.
2. 1872 cwt. COPPER RODS (not extruded).
3. About 383 Tons BRIDGEWORK.
4. One 5-Ton TRAVELLING JIB CRANE, ELECTRIC.

Tenders due on the 31st August, 1926, for No. 1, on the 10th September, 1926, for No. 2, on the 15th September, 1926, for No. 3, and on the 17th September, 1926, for No. 4.

Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returnable. 3180

Assistant Engineers (6) REQUIRED by the GOVERNMENT of NIGERIA for the PUBLIC WORKS DEPARTMENT for two tours of not less than 12 nor more than 18 months' service in the first instance. Subject to satisfactory service the officers appointed will be eligible at the expiration of three years' service for confirmation in the permanent and pensionable establishment. Salary £480, rising to £920 a year. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, preferably between 25 and 30 years of age, unmarried, must have passed the examination for A.M.I.C.E. or possess a degree in Civil Engineering recognised by the Institution as exempting from Parts "A" and "B" of the examination. They must have had proper technical training and preferably have had not less than two years' subsequent experience on large Engineering or Municipal Works. Candidates possessing other civil engineering qualifications may apply.—Applications should be made at once by letter, stating age, qualifications and experience, also whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14485. 2984

Civil Engineers (5) REQUIRED for the PUBLIC WORKS DEPARTMENT of TANGANYIKA TERRITORY for a tour of 30 to 30 months' service with possible extension. Salary £480, rising by annual increments to £720 a year (with efficiency bar at £600) payable in the Territory in local currency. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 35, preferably unmarried, must have been regularly trained as Civil Engineers and be Corporate Members of the Institution of Civil Engineers. Must be capable of levelling, surveying, measuring up work and preparing designs of bridges, &c. Must have had at least three years' experience under a qualified Civil Engineer on the construction of Harbour Works, Drainage Works, Water Supply, or other Public Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14402. 3182

The Engineer

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PUBLIC NOTICES

Civil Engineer Required by the GOVERNMENT of the GOLD COAST for the PUBLIC WORKS DEPARTMENT, for two tours of twelve to eighteen months' service, with possible extension. Salary £480 for the first three years of service, then £510, rising to £720 a year by annual increments of £30, and then rising to £920 by annual increments of £40. Outfit allowance £60 on first appointment. Free quarters and passages and liberal leave at home on full salary. Candidates, age between 25 and 35, must be fully qualified Civil Engineers holding A.M.I.C.E. or equivalent professional qualifications and have had practical and general experience on the Construction of Roads, Buildings and other Public Works.—Apply at once in writing, stating age and giving brief details of experience and qualifications, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting clearly at head of application M/14,603. 3119

Northampton Polytechnic INSTITUTE, St. John-street, London, E.C. 1. SESSION 1926-7.

ENGINEERING DAY COLLEGE.

The College provides courses in Civil, Mechanical, Electrical, Aeronautical, and Radio Engineering.

Each course occupies four years and includes provision for students to spend two summer periods, April to September, in commercial works.

Matriculated students are able to enter as Internal Candidates for the examinations leading to Degrees in Engineering of the University of London.

Students should be not less than sixteen years of age at entrance.

An entrance examination in English and Mathematics will be held on Thursday and Friday, September 9th and 10th. Classes commence Monday, September 27th.

TUITION FEES.—£18 per annum for students residing in London, Kent or Middlesex; £60 for students resident elsewhere.

Three entrance scholarships, each of the value of £18 per annum, are offered for competition at the entrance examination.

A prospectus giving full particulars will be forwarded on application to the PRINCIPAL. 3137

Northampton Polytechnic INSTITUTE, ST. JOHN-STREET, E.C. 1.

Evening Courses in ENGINEERING and in FUEL TECHNOLOGY and METALLURGY (including Metallography) for Engineers, Engineering Chemists, &c., commence on Monday, September 20th, 1926.—Prospectuses may be obtained from the PRINCIPAL. 3138

PUBLIC NOTICES

EAST LONDON COLLEGE (UNIVERSITY OF LONDON), MILE END ROAD, E.1.

FACULTIES OF ARTS, SCIENCE AND ENGINEERING (CIVIL, MECHANICAL, ELECTRICAL AND AERONAUTICAL)

FACILITIES FOR RESEARCH.
PREPARATION FOR 1st M.B. EXAMINATION.
FEES £22:2:0 a year.
HOSTELS AND ATHLETIC GROUND.
NEW SESSION COMMENCES SEPT. 27.

Particulars, Post Free. E. J. WIGNALL, Registrar. 3038

University of Birmingham. FACULTY OF SCIENCE.

ENGINEERING DEPARTMENTS.

I.—MECHANICAL ENGINEERING.
"CHANCE" PROFESSOR: F. W. BURSTALL, M.Sc., M.A. (Cantab.), M.I. Mech. E.
LECTURER: R. O. PORTER, M.Sc. (Vict.), A.M.I.C.E.
DEMONSTRATOR: S. J. ELLIS, B.Sc., A.M.I.C.E.
LECTURER ON MACHINE DESIGN: P. H. BODEN, B.Sc.
ASSISTANT LECTURER ON MACHINE DESIGN: H. P. DEAN, B.Sc.

II.—CIVIL ENGINEERING.
"BEALE" PROFESSOR: CYRIL BATHO, M.Sc., D.Sc., B.Eng.
LECTURERS: R. C. PANTON, M.Sc., A.M.I.C.E. H. W. COULTAS, M.Sc., M.I. Mech. E. T. H. P. VEAL, B.Sc., A.M.I.C.E.
LECTURER ON TOWN PLANNING: W. HAYWOOD, F.R.I.B.A.

III.—ELECTRICAL ENGINEERING.
PROFESSOR: WILLIAM CRAMP, D.Sc., M.I.E.E.
LECTURERS: E. J. KIPPS, M.Sc., M.I.E.E. G. M. HARVEY, M.Sc., B.Eng.
ASSISTANT LECTURER: L. G. A. SIMS, M.Sc.

THE FULL COURSES EXTEND OVER FOUR YEARS, and students who enter after Matriculation and pass successfully the examinations at the end of each year will be ENTITLED TO THE DEGREE OF BACHELOR OF SCIENCE in Engineering.

THE SESSION 1926-27 COMMENCES ON OCTOBER 4th, 1926.

For detailed syllabus of the Faculty with full particulars of University Regulations, Lecture and Laboratory Courses, Fees, &c., apply to the REGISTRAR. 2943

PUBLIC NOTICES

Heriot-Watt College, EDINBURGH.
Principal of College: A. P. LAURIE, M.A., D.Sc.

ENGINEERING.

Complete Diploma Courses in MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, and MINING ENGINEERING (COAL, METALLIFEROUS, OIL).

CHEMISTRY.

Complete Courses leading to the Diploma and Associateship of the College in Chemistry, the final year of training being devoted to specialisation in one or more branches of Applied Chemistry. The Courses in Chemistry also include the training necessary for the Associateship and Fellowship of the Institute of Chemistry, the B.Sc. Degree of Edinburgh University in Technical Chemistry, and the B.Sc. Degree of London University (Pass and Honours). Courses in Brewing for the College Certificate and for the Associate Membership of the Institute of Brewing.

The Associateship of the College in Chemistry is recognised by the Institute of Chemistry as exempting from Examinations for the Associateship of the Institute of Chemistry (A.I.C.).

Laboratories equipped for Research Students.

PHARMACY.

Courses for Students preparing for the Professional Examinations of the Pharmaceutical Society of Great Britain.

Courses in BUILDING CONSTRUCTION for Builders' Clerks and Surveyors, and in PRINTING for those engaged in Printing and the Allied Trades.

Entrance Bursary of £25. Schedules on application.

Classes open on 12th October.

Entrance and Bursary Examination commences on 21st September.

Prospectus on application to Principal at the College.
G. MALCOLM STUART, W.S., Clerk.

Heriot Trust Offices, 20, York-place, Edinburgh, July, 1926. 3079

The University of Sheffield. SESSION 1926-27.
Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING, METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the above Departments extend over three or four years and prepare students to become specialists in one or other of these branches of Applied Science.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular Courses.

In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students who come to the University from works or collieries to take six months' Courses of study at the University and six months' practice at the works or colliery each year for a period of four years. During the first year such students should spend three terms at the University.

The LECTURE COURSES commence OCTOBER 6th, 1926.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 28th, 1926.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to W. M. GIBBONS, Registrar. 3073

University of Manchester. PHYSICS DEPARTMENT.

Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and the Honours Degrees, will be forwarded on application to the REGISTRAR. 3129

University of Manchester. DEPARTMENT OF ELECTRICAL ENGINEERING.
DEPARTMENTS OF CIVIL, MECHANICAL AND ELECTRICAL ENGINEERING.

Full particulars of these COURSES will be forwarded on application to the REGISTRAR. The Session commences on October 7th. 3128

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PUBLIC NOTICES

The Polytechnic, 309, Regent STREET, W. 1.

SCHOOL OF ENGINEERING.

President of the School: The Hon. Sir CHARLES PARSONS, K.C.B., M.A., LL.D., D.Sc., F.R.S., &c.
Head of Department: ALEX. R. HORNE, O.B.E., B.Sc. (Hons. Eng.), F.R.S. (Edin.), &c.

The DAY DEPARTMENT RE-OPENS on SEPTEMBER 21st, 1926. Entrance Examination commences September 6th, 1926, at 9.30 o'clock.

Three-year DIPLOMA COURSES in
MECHANICAL ENGINEERING.
ELECTRICAL ENGINEERING.
MOTOR CAR ENGINEERING.

Practice in the Laboratories, Drawing-office, Workshop and Field.

Fee 21 Guineas per annum.

THE EVENING DEPARTMENT re-opens on September 27th, 1926. Students enrolled from September 15th, 1926.

The Day and Evening Courses are recognised for the Diplomas and Certificates issued by the Institutions of Mechanical and Electrical Engineers in conjunction with the Board of Education.

Full prospectus free on application to the DIRECTOR of EDUCATION. 3080

The Royal Technical College, GLASGOW.

DEPARTMENTS OF ENGINEERING.

MECHANICS AND MECHANICAL ENGINEERING: Professor ALEXANDER L. MELLANBY, D.Sc., M.I. Mech. E.
Associate Professor WILLIAM KERR, Ph.D., A.R.T.C.
ELECTRICAL ENGINEERING: Professor STANLEY PARKER SMITH, D.Sc., M.I.E.E., A.M. Inst. C.E.
CIVIL ENGINEERING: Professor GEORGE MONCUR, B.Sc., M. Inst. C.E., M. Amer. Soc. C.E.
MINING ENGINEERING: Professor DANIEL BURNS, M. Inst. M.E.
CHEMICAL ENGINEERING: Professor of Technical Chemistry: THOMAS GRAY, D.Sc., LL.D., Ph.D., F.I.C.

Complete Courses of Instruction are provided, qualifying for the Diploma of the College and for the Degree of B.Sc. in Engineering of Glasgow University.

Composition fee 25 guineas per annum.

SESSION 1926-7 BEGINS on TUESDAY, SEPTEMBER 21st.

Calendar, by post, 3s., and prospectus, gratis, may be obtained on application to the DIRECTOR. 2848

University of London. University College.

FACULTY OF ENGINEERING.

SESSION 1926-27.

Dean and Director of the Engineering Laboratories: E. G. COKER, M.A., D.Sc., M. Inst. C.E., F.R.S., Professor of Civil and Mechanical Engineering.
Vice-Dean: M. T. M. ORMSBY, M. Inst. C.E.I., Professor of Municipal Engineering.

THE SESSION BEGINS ON MONDAY, 4TH OCTOBER, 1926.

DEGREE AND DIPLOMA COURSES.

Students desirous of entering the Faculty of Engineering with a view to taking a full Degree or Diploma Course must have passed the Matriculation Examination or some other Examination accepted in its stead.

SPECIAL COURSES.

Students who have already undergone a partial training elsewhere and who have attained a sufficient standard, may enter for a course occupying less than three years, and may obtain a General Certificate of Engineering after not less than two consecutive sessions' attendance.

POSTGRADUATE WORK AND RESEARCH.

Graduates in Science or Engineering, or students who have done the work equivalent to a degree, may be admitted to Special Courses of study, or to prosecute original research.

ADMISSION.

INTENDING STUDENTS should communicate with the Secretary forthwith, and send a full statement of their previous training.

EXTENSION OF BUILDINGS.

Under the scheme of development begun five years ago, about £56,000 has been expended in buildings and equipment to increase existing facilities for training in the principles of science, which forms the foundation of sound engineering practice, and work is still in progress.

The NEW BUILDINGS, including the Charles Hawksley Hydraulic Laboratory, a Machine Tools Workshop, and a new Laboratory for Experimental Work, are now in full use.

Particulars may be obtained on application to the undersigned.

WALTER W. SETON, Secretary.
University College, London (Gower-street, W.C. 1).
3118

COUNTY BOROUGH OF WEST HAM.

West Ham Municipal College.

SESSION 1926-27.

DAY and EVENING COURSES in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING, under recognised teachers of London University.

Matriculated Students are recognised as "Internal" Students of the University.

Enrolment of students, September 13th to 17th.

Particulars of these and other courses in the prospectus to be obtained from the Principal.

GEORGE E. HILLEARY, Town Clerk.
18th, August, 1926. 3139

City of Manchester.

The Electricity Committee of the Manchester Corporation invite TENDERS for the following WORKS required in connection with the EXTENSION of their BARTON POWER STATION:—

Contract No. 9.—FOUNDATIONS, PRELIMINARY WORKS and SUPERSTRUCTURE.
Contract No. 10.—STEELWORK in STORES EXTENSION.

Specifications, quantities and forms of Tender may be obtained on application to Mr. H. C. Lamb, Chief Engineer and Manager, Electricity Department, Town Hall, Manchester, on payment of a fee of Two Guineas for each specification, which amount will be refunded on receipt of a bona fide Tender.

Drawings may be seen at the offices of Messrs. C. S. Allott and Son, Civil Engineers, 1, North-parade, Manchester.

Tenders, duly endorsed and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than 10 a.m. on Wednesday, 8th September, 1926.

The firms entrusted with the work will be required to enter into a contract to be prepared by the undersigned.

The Corporation do not bind themselves to accept the lowest or any Tender.

P. M. HEATH, Town Clerk.
Town Hall, Manchester.
16th August, 1926. 3160

The Madras and Southern MAHRATTA RAILWAY COMPANY, Limited,

25, Buckingham Palace-road, Westminster, S.W. 1, invite TENDERS for—

(1) SEVEN 131ft. 0in. CLEAR-THROUGH GIRDER SPANS (total approximate weight, 980 tons).
(2) 6265 HELICAL and VOLUTE SPRINGS.
(3) 6000 STEEL BOILER TUBES (Solid drawn).

Tenders are also invited—

For (1) on Tuesday, 31st August, 1926, by 2 p.m.; for (2) and (3) on Tuesday 7th September, 1926, by 2 p.m.

Tender forms obtainable at above address; fee, One Guinea each, which is not returnable.

The Directors do not bind themselves to accept the lowest or any Tender. 3130

PUBLIC NOTICES

Leatherhead Urban District COUNCIL.

SEWERAGE WORKS.

The above Council invite TENDERS for the CONSTRUCTION of TANKS, PERCOLATING and CONTACT FILTERS, CHANNELS, SEWERS, SLUDGE TANKS, PUMPS, DRYING AREA, STORM WATER TANKS, and other appurtenant WORKS, at the Outfall, Randalls-road, Leatherhead.

Specification and drawings of the proposed works may be inspected at the office of Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Victoria-street, Westminster, S.W. 1, and copies of the bill of quantities and form of Tender obtained, on deposit of a crossed cheque for £3 3s., made payable to the Council, which deposit will be returned on receipt of a bona fide Tender.

Sealed Tenders, on the forms provided, are to be delivered to the undersigned not later than Noon, Monday, 6th September, 1926.

The Council do not bind themselves to accept the lowest or any Tender.

By Order, W. J. HODGES, Clerk to the Council.

Council Offices, Leatherhead, Surrey, 27th July, 1926. 3028

British Cast Iron Research ASSOCIATION.

The Council invites APPLICATIONS for the POST of SENIOR METALLURGIST. Candidates should have University qualifications in Metallurgy and subsequent Research Experience. Commencing salary not less than £800 per annum. A memorandum on the conditions of the appointment and duties involved may be obtained on application to the DIRECTOR, 75, New-street, Birmingham, to whom applications should be addressed not later than the 15th September 1926. 3101

The Institution of Structural ENGINEERS.

MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.

A MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP for candidates of and over 25 years of age who have at least 10 years' experience (including time served in apprenticeship or articles) is HELD QUARTERLY. It consists of an examination in Design worked privately by the candidate in the course of his practice at home. The NEXT EXAMINATION will take place on 18th SEPTEMBER (papers posted on the 17th), and entries must be in by 13th September. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY, Secretary of the Institution.
10, Upper Belgrave-street, S.W. 1. 3135

Sudan Government.—Assistant

MANAGER REQUIRED for Omdurman Technical School. Candidate should have been trained in General Metal Working, including trades of Blacksmith, Coppersmith, Tinsmith, &c., and must be able to teach these subjects. Candidate should possess Teaching Diploma of the City and Guilds or equivalent Institution. General knowledge of Building Construction and Allied Subjects would be a considered an advantage. Age 25 to 32, preferably single. Commencing salary, £400 per annum. Pensionable and progressive post if permanently retained. Free second-class passage. Strict medical examination. Liberal leave on full salary with assistance towards cost of passage.—Apply by letter, with full particulars regarding education, technical qualifications, practical experience and personal references, together with copies of certificates and testimonials, to ADVISORY ENGINEER, Sudan Government London Office, Wellington House, Buckingham Gate, S.W. 1, marking envelope "Asst. Manager." 3143

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED for India, ENGINEER-SALESMAN. Good technical man, competent to handle contracts for power equipment of Textile Mills and Power Station Work. Will be attached to Indian Agents, headquarters Bombay. Previous Indian experience desirable, but not essential. Age 30-35. Good salary and commission. A man of good and strong character and a worker essential.—Apply, stating age, terms expected, with full particulars of past experience, to the MANAGING DIRECTOR, Hick, Hargreaves and Co., Ltd., Soho Ironworks, Bolton. 3084 A

WANTED, MECHANICAL ENGINEER ASSISTANT in large works, to Superintend Repairs, Steel Wagons, Rolling Stock, Cranes and Heavy Mines Machinery; knowledge of Spanish desirable, not essential; age 30-35.—Apply, stating age, experience, salary, &c., to "K. A.," c.o. Streets, 6, Gracechurch-street. 3131 A

WANTED, TRAVELLER for Midlands, and One for London, by well-known firm of Tool Steel makers. Applicants with thorough knowledge of the trade are invited to send fullest particulars of their qualifications.—Address, P2180, The Engineer Office. P 2180 A

WANTED, WORKS MANAGER for Locomotive and Carriage Shops on South American Railway; must have at least 12 years' Railway and Locomotive Experience, not less than 7 years in control of workmen, and possess some knowledge of Spanish.
Address, giving statement of career, age, and whether married or single, also copies of testimonials, 3145, The Engineer Office. 3145 A

ASSISTANT ENGINEER REQUIRED, University training, engineering degree, and contractor's experience essential. Age not to exceed 28 years.—Apply in first instance in writing, stating age, full particulars of training and experience, to SECRETARY, Brunner, Mond and Co., Ltd., Northwich, Cheshire. 3105 A

CIVIL ENGINEER, with Special Knowledge of Brick Buildings, WANTED for first-class English Contracting Firm in India. Excellent prospects; Public School man preferred; age 28, unmarried; five years' agreement.—Apply, with copies of testimonials, and photograph (if possible), to "Z.Y. 529," c.o. Deacon's Advertising Agency, Fenchurch-avenue, E.C. 3. 3163 A

MECHANICAL ENGINEER, to Manage Rolling Mills in India, WANTED.—Write, giving fullest particulars, to Box G.G., c.o. Davies and Co., 95, Bishopsgate, E.C. 2. 3127 A

OPENING for Small Premium-paying APPRENTICE in Engineering Firm; marine specialities.—THE LANGDON ENGINEERING COMPANY (1924), Ltd., Bond-street, Northam, Southampton. P2172 A

REQUIRED for India, CIVIL ENGINEER, Experienced in Concrete Design; age approximately 34 years; bachelor, public school and University man preferred.—Address, giving full particulars, 3172, The Engineer Office. 3172 A

SITUATIONS OPEN (continued)

RATE FIXER WANTED, with Good Experience, for Motor Work (London).—Applications, stating age, experience and salary required, to be addressed to 3132, The Engineer Office. 3132 A

SERVICES REQUIRED.—ENGINEER, Regularly trained in Mechanical and Electrical Branches, as SENIOR for Department handling Plant and Machinery requirements for overseas trade. Commercial experience is essential, and applicants should have previously held positions fitting them to handle contracts from tender to shipment, inclusive of lay-out, purchase and inspection.
Give in strict confidence particulars age, experience, present salary and salary expected, to C. M., 64, Cannon-street, London, E.C. 4. 3087 A

WANTED, DRAUGHTSMAN for Jigs and Tools.—Address, stating age, experience and salary required, 3175, The Engineer Office. 3175 A

WANTED, DRAUGHTSMAN for Mechanical Construction Work.—Apply, stating experience, age, salary, &c., to "H. S.," c.o. Streets, 6, Gracechurch-street, E.C. 3. 3133 A

WANTED, JUNIOR DRAUGHTSMAN for Machine Design.—Address, 3173, The Engineer Office. 3173 A

WANTED, in Railway Engineer's Office in London, a Thoroughly Competent and Experienced DRAUGHTSMAN for Steel and Reinforced Concrete Structural Work. State age, experience and salary required.—Address, 3181, The Engineer Office. 3181 A

DRAUGHTSMEN.—FIRST-CLASS CIVIL ENGINEERING DRAUGHTSMEN REQUIRED TEMPORARILY in Railway Engineer's Office in London; must be thoroughly experienced in all kinds of Structural Work and able to work with a minimum of supervision.—Address, stating age, experience, and salary required, 3147, The Engineer Office. 3147 A

DRAUGHTSMAN REQUIRED, Experienced in the design of Water-tube Boilers and Accessories both for land and marine work. Applicants must give full details of past experience, stating age and salary expected.—Address, 3110, The Engineer Office. 3110 A

DRAUGHTSMAN WANTED, with Up-to-date Experience in Boring and Turning Mill Design.—Apply, stating age, wage and full particulars of experience, to WEBSTER and BENNETT, Ltd., Northey-road, Coventry. 3141 A

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STRUCTURAL DRAUGHTSMEN REQUIRED. North-East Coast: well up in Design and Detailing; only men experienced in this class of work need apply. State salary required.—Address, 3148, The Engineer Office. 3148 A

TWO First-class STRUCTURAL DRAUGHTSMEN REQUIRED for London. Must be conversant with requirements of L.C.C. Building Act for Steel-framed Buildings. Capable of surveying sites and be responsible for detailing of steel contracts in their entirety. Age, experience, salary required.—Address, 3183, The Engineer Office. 3183 A

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FOREMAN REQUIRED, Used to Machine Shop Repetition Work, Assembly of Counter and Small Indicating Instruments; North London. Particulars of experience and salary.—Address, P2170, The Engineer Office. P2170 A

BLACKSMITHS (TWO) WANTED for Queensland. First-rate men, preferably used Agricultural Machinery Forgings.—Address, 3149, The Engineer Office. 3149 A

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SITUATIONS WANTED

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QUALIFIED CIVIL ENGINEER, Formerly President of well-known Professional Society, retired from an important position on railway, special knowledge railway, bridge, tunnel, &c., construction, and all forms of structural engineering, is tired of living in retirement, and being still comparatively young and very active, DESIRES SOME ENGINEERING WORK of any description, whether supervisory or in any capacity; small salary wanted (£360 or £400 p.a.) for expert services. The main thing is to have some work to do to maintain interest in life.—Address, 3171, The Engineer Office. 3171 B

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ADVERTISER WISHES to MEET 1 or 2 GENTLEMEN with £5/10,000 each, to take over substantial and old-established business (foundry) at low valuation. Well-trained staff and good business, but capital needed.—Address, P2148, The Engineer Office. P2148 C

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P2140 I

For continuation of Small Advertisements see page 3.

A Seven-Day Journal

The Earthquake.

Just before or soon after five o'clock on the morning of last Sunday, August 15th, widespread alarm was caused throughout the Midland and Southern areas of England by an earthquake. The tremors lasted from 5 to 60 seconds, and were sufficiently marked to ring bells, crack ceilings, throw down crockery and effect other minor damage. No lives were lost, and no cases of injury were reported. In most cases the shock was preceded or followed by a long-drawn rumbling noise. The movement was felt at places as far apart as Birmingham, Ludlow, Bristol, Seaton, Bath, Highgate, and Peterborough. The districts affected have experienced earthquakes and tremors previously, but the widespread area practically simultaneously affected makes last Sunday's visitation noteworthy. In a leading article in this week's issue, we deal with the effect of variations in the atmospheric pressure on the earth's crust. Forty-five years ago Mr. Henry Harries, of the Meteorological Office, began to issue anonymously, colliery warnings, urging miners to beware of gas escapes in the workings during periods of high pressure. In the face of strong opposition, he maintained that it was high and not low pressures that led to the invasion of the workings by fire-damp. His views were based on the belief that the earth's crust breathed under changes of atmospheric pressure, and that when the load increased, the surface vents were closed and the gas driven down into the mine passages and chambers. The breathing movement when the load rose caused, in his view, not only an influx of gas, but might set up earth tremors and vibrations. He, and others have reached the same conclusion, held that seismic tremors and even severe earthquakes might owe their origin simply to the overloading effect of an anticyclone. We have therefore examined with interest the distribution of atmospheric pressure over the British Isles on the day of the visitation. The barometer last Sunday was high over the whole of the British Isles, with an ascending gradient towards the South. Almost without exception, all the places reported to have experienced the tremor or shock lie within the area of highest pressure recorded over the country on Sunday, namely, between the 29·88in. isobar running almost due west from the Wash and the 30·00in. isobar running between the Isle of Thanet and the Isle of Wight.

Wages in the Engineering Industry.

On Tuesday, August 17th, a conference was held at York of representatives of the unions concerned in the application for an all-round advance of 20s. per week in the wages of workmen engaged in the engineering industry. The eighty members attending the conference represented twenty-five unions. Following a report on the position in different parts of the country, a discussion took place on the situation in all its varied aspects. Ultimately, a resolution was passed to the effect that, in view of the present industrial situation and the circumstances surrounding the engineering industry, the conference should be adjourned until such time as the conditions were more favourable than at present.

Japanese Aviation.

A movement is on foot in Japan for the rapid development of the country's commercial and military aerial forces. While the extent to which the Army is to develop its air arm has not been disclosed, it is reported that a company is being formed to operate a commercial fleet which, in conjunction with the military air force, will ensure Japan's aerial supremacy in Asia. The proposed commercial company is, it is stated, to receive a subsidy of about £1,000,000 from the Japanese Government, and has for its object the building of a commercial fleet equalling in strength that of France, England or America. If the company chooses to follow the example of this country, its project need not be regarded as over-ambitious. The Imperial Airways organisation, which is also in receipt of a Government subsidy of a million pounds, has in use no more than fourteen machines, with a total seating capacity of but 178. It is held in Japan that a rapid development of the country's aerial forces is greatly preferable to increasing the number of battleships and merchant vessels. In conjunction with the Army and Navy, such air forces would, it is argued, ensure Japan's commercial position in Asia.

The Scapa Flow Salvage Operations.

During the past seven days considerable progress has been made in the raising of the scuttled ex-German battle-cruiser Hindenburg at Scapa Flow, and the salvage operations are now believed to be within measurable distance of success. The method employed by Cox and Danks, Ltd., was to seal up all deck and side openings, and to float the hull by pumping out the water in stages. Pumping operations were begun on the forward part of the ship over a week ago. As soon as this work was completed and the water removed from compartments nearer amidships, the fore part of the ship was made buoyant. This part of the hull, covered with a heavy growth of seaweed, now stands well above water. As pumping operations were continued on the centre and aft compartments on Tuesday last, a marked list to port, estimated at from 15 deg. to 20 deg., was developed, which is now being corrected by trimming, and by additional side anchorage. In order to counteract any possible tendency for the Hindenburg to heel over, one of the destroyers which had already been salved, and from which the machinery had been removed, was sunk in a convenient position off the Island of Cava, and connected by a stout hawser to a point on one of the masts of the battle-cruiser. It was found that the stern of the ship had settled down on a mass of rock, which had buckled, if not pierced both the inner and outer skins of the hull. When the final patching and trimming operations are completed, it is proposed to pump out the remainder of the compartments. The hope is expressed that the whole of the ship will be afloat well above water at no distant date.

Submarine Sound Signalling.

In order to test the merits of submarine sound signalling for indicating the position of a lightship in crowded waters in time of fog, when visual signals are useless and even above-water sound signals are frequently deceptive, both as regards direction and distance, the Corporation of Trinity House will shortly equip two lightships with submarine sound signalling apparatus, consisting of a submarine oscillator attached to the hull of the lightship. The diaphragm of this oscillator is to oscillate at a frequency of 1050 vibrations per minute, and the resultant note travelling through the water will be picked up by ships equipped with hydrophones at a distance of 15 to 20 miles. A development of the system, which is in use off the Danish coast, and at the mouths of the rivers Ems and Meuse, is to combine with the underwater sound signal a wireless signal, transmitted simultaneously in the ordinary way. The speed of the latter is, of course, equal to that of light, whilst the sound travels through the water at a speed of one mile in 1·3 seconds. The operator on the ship naturally hears the wireless signals before the sound signals, and the number of dots received before the hydrophone responds enables the operator to arrive at the distance the ship is from the sending station.

The Shipbuilding Trades Investigation.

On Tuesday of this week, August 17th, the Shipbuilding Trades Federation met at York, and for a period of four hours discussed the report of the joint committee of employers and workmen on the effect of foreign competition in the shipbuilding industry and on the prosperity of the industry generally as affected by internal conditions. The whole of the unions covered by the industry were represented by members of their executive councils. The Conference was conducted in private, but at its close it was officially stated that it felt that the work of the joint committee had been well done. Regret, however, was expressed that fuller information had not been given regarding the financial resources of the firms engaged in shipbuilding and ship repairing. Considerable difference of opinion arose as to the application of the report, and it was arranged that further opportunity should be given for consultation with the members of the unions. To enable this end to be achieved, the meeting was adjourned until September 23rd.

The Progress of Aeronautical Research.

The annual report of the Aeronautical Research Committee for the year 1925–26 was issued this week. It reveals almost a new orientation in aeronautical developments. The report speaks in a very hopeful strain of the promise conveyed by the advent of the Cierva autogyro and the Hill tail-less aeroplane, and remarks that they will make the conventional type of aeroplane no longer the only successful form of heavier-than-air craft. In connection with aero-engine design, too, revolutionary ideas are at work. Progress is being made with the thorny problem of supercharging, and with the almost as difficult one of preventing detonation. In the second named connection it has been definitely proved that the absence of hot exhaust valves diminishes the tendency to detonation, and, as a consequence, attention has been directed to the development of single sleeve-valve aero-engines. By the use of sleeve valves in place of poppet valves higher compression ratios can be used and important gains in efficiency realised. The research work on this subject, it is considered, has now reached such a stage that the development of multi-cylinder aero-engines using sleeve-valves should be encouraged. We read, too, that the Engine Sub-Committee is interested in the possibilities of compound expansion in aero-engines, and that a special unit is being constructed to investigate the question. The airless-injection compression-ignition engine for aeronautical purposes is also receiving attention. In the field of pure aerodynamics a research has been begun on the air flow round rotating cylinders. This investigation has, as its object, the discovery of the virtues of the proposal to make use of the "Magnus effect" in aeroplanes by employing a rotating cylinder either as part or as the whole of a wing. The work done on this subject so far shows that the lift coefficient obtained is undoubtedly very high, but that the relative resistance is great, too great, it is thought, to induce designers to face the problems involved in substituting rotating cylinders for the conventional pattern of wing. It is admitted, however, that an investigation of the scale effect may alter this tentative verdict.

A Large Motor Train Ferry.

The motor train ferry Dolores D'Urguiza, which was recently launched from the Pointhouse Yard of A. and J. Inglis, Ltd., Glasgow, is claimed to be one of the largest railway ferries of its type yet constructed. It has been built to the order of the Entre Rios Railways, of Uruguay, and will be used for service across the Parana River, a distance of about 50 miles, which will be covered in close upon four hours. The new ferry is equipped with four sets of rail tracks, which are designed to carry thirty-three wagons, each of 40 tons capacity. Besides the trains, passengers and cargo will also be transported. The principal dimensions of the hull are as follows:—Overall length, 355ft. 6in.; breadth moulded to main deck, 57ft. 6in.; extreme breadth over belting, 59ft. 7in., and moulded depth, 19ft. 9in. The propelling machinery, which is housed in an engine-room slightly aft of amidships, comprises twin-screw six-cylinder Harland-B. and W. marine oil engines, each designed for an output of 700 brake horse-power when running at a normal speed of 200 revolutions per minute. As the ferry must work to a railway time-table schedule, supercharging blowers have been fitted to the engines, which will enable a power 10 to 15 per cent. in excess of the normal rated output to be obtained. By this means it will be possible to increase slightly the normal service speed of 11½ knots should this at any time be found desirable. The deck house, in which accommodation for the pilots and the captain is provided, is like the wheel house, built well above the deck on long columns so that the trains can pass underneath. About 100 tons of oil fuel will be carried in a special tank which is built forward of the engine-room.

The Coal Dispute.

On Tuesday, August 17th, a hopeful development took place in the coal dispute. On that day the adjourned meeting of the miners' delegate conference in London authorised its executive by a card vote of 428,000 to 360,000, to reopen negotiations with the Government and the coal owners for a settlement of the points at issue. It was specified that the negotiations were to be conducted on the basis of a national settlement and not on one of separate district settlements. There was a danger that if some attempt were not soon made to bring about peace in the industry certain of the districts, notably the Nottinghamshire and Derbyshire districts, would enter into negotiations for local settlements. So much was admitted by one of the Nottinghamshire delegates, Mr. G. A. Spencer, M.P., whose resolution to empower the executive to open negotiations with the coal owners, unfettered by any conditions, other than that the proposed terms should be submitted to a ballot vote gave rise to a lively discussion. The South Wales, Lancashire and Yorkshire delegates are understood to have voted against Mr. Spencer's resolution, which was only carried after the Scottish representatives, at first also against it, had recanted. In spite of the terms of the resolution it is understood that the executive will not only refuse to discuss district agreements but also any increase in the length of the working day from seven to eight hours. If this be so then the only subject on which negotiations can proceed is the question of wages, a subject on which very little, it would seem, remains to be said. On Wednesday the Miners' Federation approached the owners' organisation direct without the Government's intervention, and arranged for an immediate opening of negotiations. The two bodies agreed to meet on Thursday (yesterday). At the moment of writing the position is still somewhat obscure, for, while the owners have intimated that no meeting could be expected to yield a fruitful result unless the miners were prepared to discuss the questions of local agreements and longer hours, the men's representatives appear still to insist upon excluding these questions from consideration.

The New Liverpool-Manchester Road.

The Ministry of Transport has at last given its approval of the construction of a new road between Liverpool and Manchester, the cost of which is estimated at about £3,000,000, of which amount the Government is to provide 75 per cent. The route to be followed, as at present arranged, will be fairly direct. It will lie slightly north of St. Helens and Newton-in-Makerfield, and will then follow a north-easterly direction south of Leigh, Tyldesley, and after passing Roe Green will drop south into Salford. There is a possibility that the road may be ultimately carried into Yorkshire without passing through Manchester. The route to Salford avoids existing roads. Manchester is not contributing anything to the cost of the thoroughfare, as the City Fathers look upon the scheme as likely to be harmful to the Ship Canal—an attitude which is similar to that adopted by the railway companies when the Canal was projected.

New Electrical Equipment at Southampton Docks.

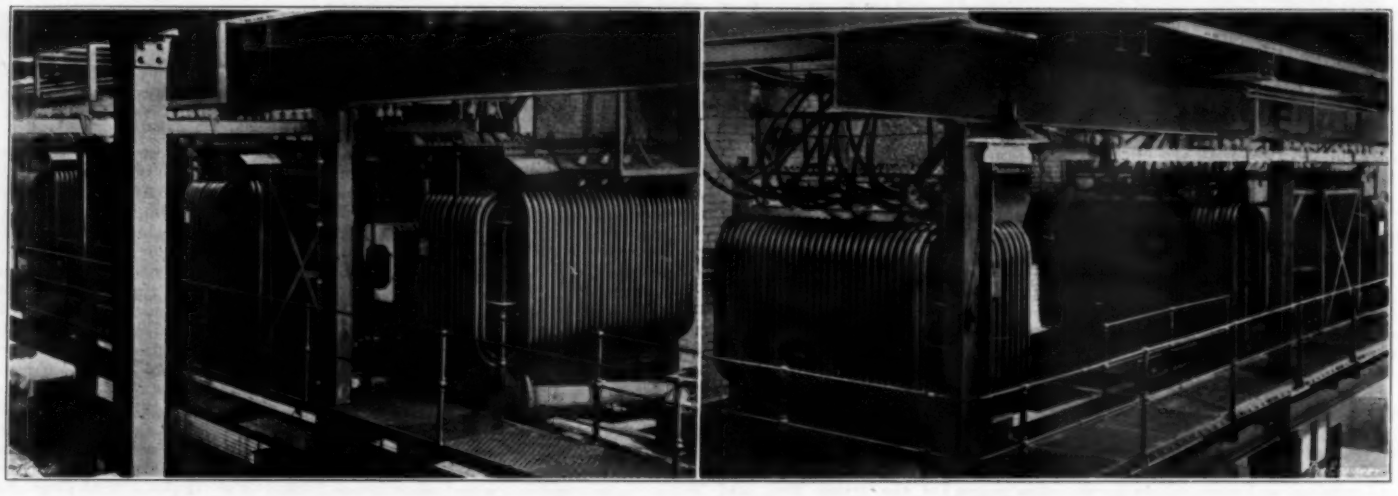
No. I.

The de-watering plants for the various graving docks at Southampton, as well as the hydraulic pumping installations, have recently been remodelled, electricity having been substituted for steam as a motive power. By the courtesy of the Southern Railway Company and of Mr. Harry Wauchope, the electrical engineer of the Docks and Marine Department of that line, we have had facilities for inspecting the new installation, and are enabled to give to our readers the following description of the arrangements as they now exist.

Although electricity has been used for lighting the docks at Southampton for many years now, it is somewhat curious to find that, up to fifteen years or so ago, electric power was only used for operating some grain-handling machinery and a 50-ton crane. Originally there was a quite small steam-driven generating station which had a capacity of approximately 200 kilowatts. Then in 1903 a larger station containing two 500-kilowatt sets was built, and one of those sets was capable of taking the whole of the load. Twenty years later, when numerous electric cranes had been installed, the load had only increased to about 1000 kilowatts, and in the meanwhile 600 kilowatts of additional plant had been put into service at the station, which already contained the two 500-kilowatt units. That was the condition of affairs when, in 1923, the management of the Docks decided to make a very considerable extension in the use of electricity, and to employ it for operating the dock de-watering plants and the hydraulic pressure pumps, as well as in the directions for which it had previously been used. This decision was, in a way, forced upon it—the management—because the Railway Company, since it had no graving dock large enough to accommodate the great liners that were proposing to make Southampton their starting point, had recently purchased the huge floating dock which is capable of lifting vessels weighing 60,000 tons and which requires electrical energy to the extent of 1200 kilowatts to operate it. The decision to change from steam to electricity was also, possibly, influenced to some extent by the fact that the then existing pumping machinery was fast getting old and obsolete, and would, in any case, have soon had to be replaced by modern and more efficient plant.

The decision arrived at, Mr. Wauchope was instructed to prepare a scheme for the electrification of all the stationary steam-driven plant in the docks, and he did so. It was, of course, realised from the first that the change-over would entail a greatly increased consumption of electrical energy, and it was evident that either some extensions would have to be made to the existing generating station or that an additional source of supply would have to be sought. It was found that the extra power required would amount to a total of some 4000 kilowatts, and the question then arose as to how best to make provision to meet the demand. It is doubtful whether the Electricity Commissioners would have sanctioned the building by the railway company of extensions to its existing generating station or the erection of a new and larger station; but in any case the company did not attempt to obtain such sanction. Instead, it entered into an agreement with the Corporation of Southampton to supply its total requirements, and did away with its own generating station. That point settled, Mr. Wauchope was free to invite tenders for the work, which he did in May, 1923, with the result that the contract for the whole of the work in connection with the graving dock de-watering arrangements was entrusted to Gwynnes Engineering Company, Ltd., of Hammersmith, the sub-contractors for the motors being the English Electric Company, Ltd., for the control gear Electric Control, Ltd., and for the valves J. Blakeborough and Sons, Ltd. The work was duly completed and has been in very successful operation for some little time now.

To give our readers some idea of the magnitude of the work involved in operating the Docks as a whole we give on page 189 a reproduction of a plan of the whole undertaking. Apart from the graving dock de-watering plants the large numbers of hydraulic and electric cranes which are arranged along the various wharves all have to be supplied with energy, and the aggregate power of the motors, which are connected to the mains is in the neighbourhood of 5000 kilowatts. Then, in addition, there is the current used for lighting. As a matter of fact, however, by refraining as far as possible from running some of the large pumping units simultaneously, the maximum demand is, as a rule, restricted to about 3500 kilowatts.



FIGS. 1 AND 2—1100 K.V.A. 3-PHASE 6300/330 VOLT AIR-COOLED TRANSFORMERS

The Main Sub-station.

It was decided to use Pumping Station No. 6, which will be observed at the top of the plan, to the westward of the Trafalgar Graving Dock, as the main supply centre, and to it the supply mains of the Southampton Corporation, which convey 6600-volt, three-phase, 50-cycle current, were led. This central station contains, in addition to pumping sets, machinery for converting the three-phase current into 480-volt direct current, for use for various purposes in the docks, as well as the necessary transformers for reducing the pressure. It is a compactly arranged building, with the machinery and equipment at three different levels. First of all, at a depth of 25ft. 6in. below ground level, there is the dock de-watering machinery, &c. At the ground level, carried on a steel joist structure, there are the converting machinery and switchgear, while on an intermediate gallery there are the transformers for supplying the rotary converters and the extra high-tension stator switchgear used for operating two of the main pumps, as will be explained in due course. The Corporation supply is led into two extra-high-tension ironclad switches of Reyrolle and Co.'s manufacture, which, in turn, through a metering panel, supply a seven-panel extra-high-tension consumer's distributing switchboard, which is of the draw-out truck type manufactured by the Metropolitan-Vickers Electrical Company, Ltd. The panels are equipped with the usual oil switches fitted with overload and earth leakage protection. Three of the panels supply three 1000-kilowatt rotary converters, which are of the General Electric Company's normal six-phase, self-starting and synchronising type. The running up to speed of these machines is effected from the alternating-current side by means of pony motors. The necessary transformers, which were supplied by the British Electric Transformer Company, are referred to again below. From the coverters low-tension direct current is led to a main direct-current distribution board which controls the general docks load, the floating dock supply, and one of the de-watering pumps, as will be explained in due course.

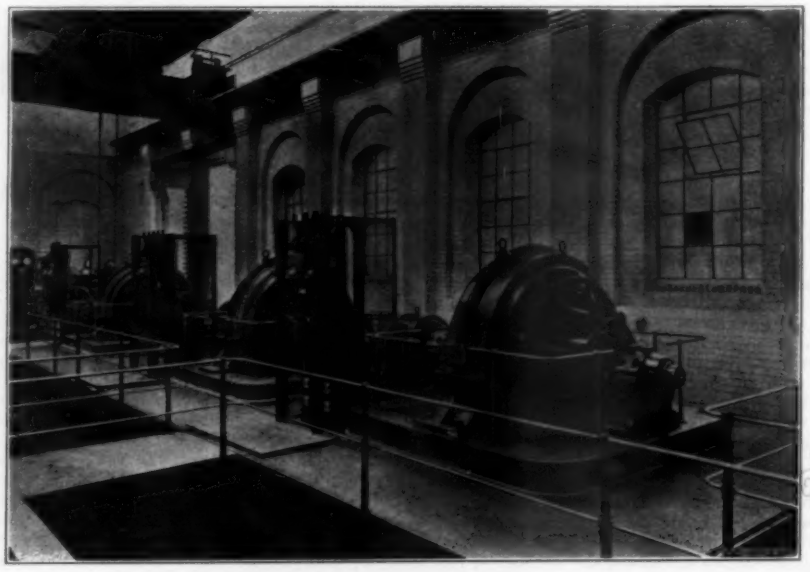


FIG. 3—1000 KW. ROTARY CONVERTERS IN NO. 6 PUMPING STATION

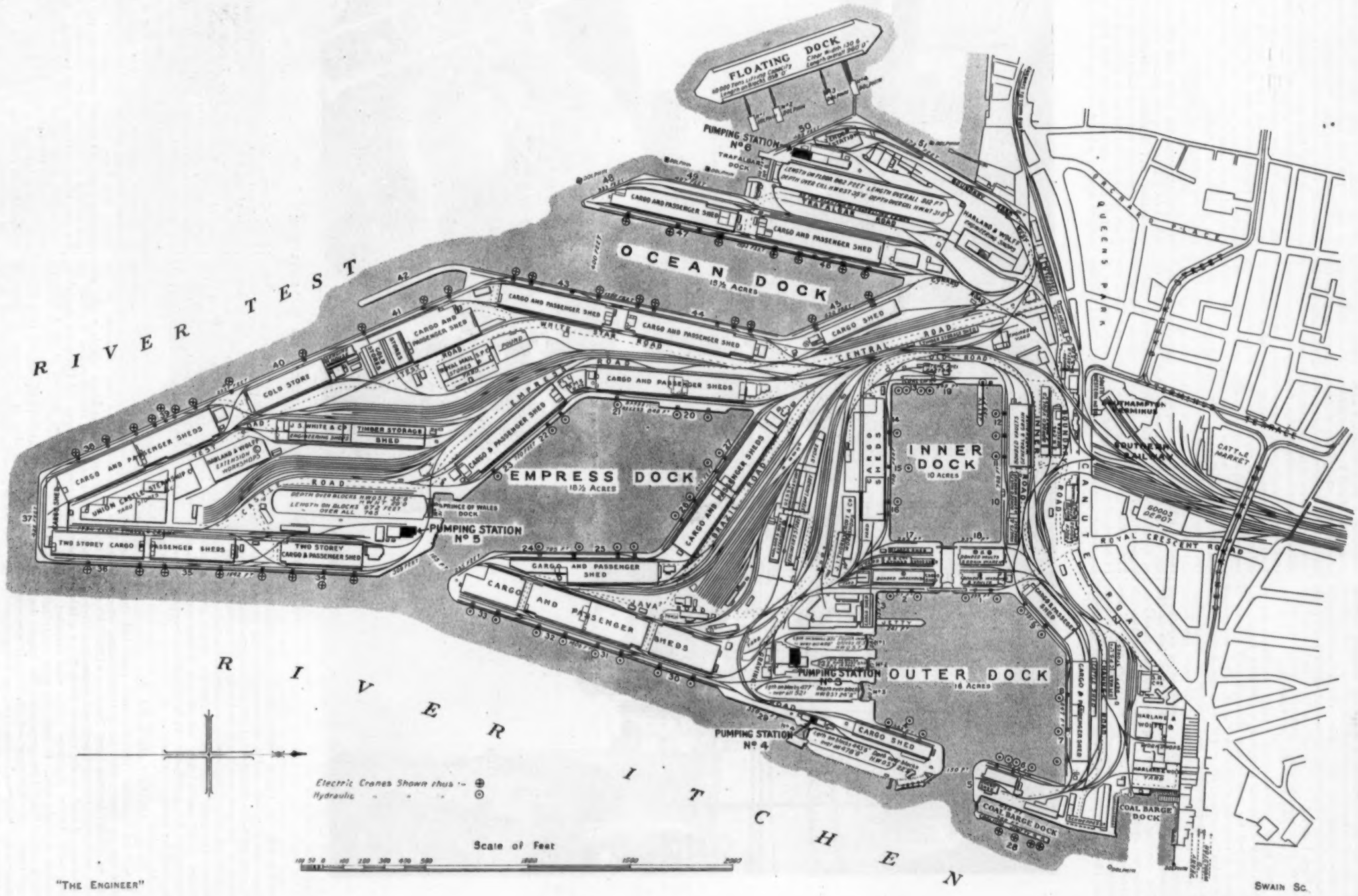
The Transformers.

The transformers employed in this sub-station were, as already stated, supplied by the British Electric Transformer Company, Ltd., of Hayes, Middlesex. We may here, in order to prevent repetition, say that this firm provided the following transformers for use in various parts of the Docks:—

Three 1100 k.V.A. ..	Station No. 6 ..	6300/330 volts
Two 400 k.V.A. ..	Station No. 3 ..	6300/415 volts
One 300 k.V.A. ..	Station No. 4 ..	6300/415 volts
Two 275 k.V.A. ..	Station No. 5 ..	6300/330 volts
One 50 k.V.A. ..	Station No. 4 ..	6300/415 volts

These transformers are all of the three-phase oil-cooled type, wound for 50-cycle current. They are all of what is known as the "Berry" core type. The core plates are bolted together by insulated tubes—and not by solid bolts—so as to minimise the hysteresis and eddy current losses. The framework consists of a form of box girder specially designed to allow of absolute freedom of oil circulation. In the 1100-kilovolt-ampère size the cores are divided by vertical oil gaps for the purpose of more effective internal cooling. The windings are of the concentric type, the low-tension winding being arranged next the core. The insulation between the windings and between the inner winding and the core, consists of stout bakelite cylinders, with end rings of similar material. The low-tension windings are actually

SOUTHAMPTON DOCKS, PLAN SHOWING POSITIONS OF DOCK DE-WATERING PUMPING STATIONS



"THE ENGINEER" SWAIN Sc.

wound on their cylinders, whilst the high-tension windings consist of former-wound coils subsequently assembled on their cylinders. Facilities for taking up shrinkage are provided by clamping devices, both at the top and bottom of each limb.

Two views of the three 1100-kilovolt-ampère transformers in position in the sub-station are given in Figs. 1 and 2.

The Rotary Converters.

The three 1000-kilowatt rotary converters are of the General Electric Company's standard design, and do not call for any special description. A view of them in position is given in Fig. 3. They are wound for a leading power factor of 0·95 at the normal direct-current voltage of 480, and take their alternating-current from the supply mains through the transformers at 330 volts. Each machine is capable of direct-current voltage variation of from 460 to 510. The starting panels are adjacent to the machines, while the direct-current switchboard for the 480-volt three-wire system is on the opposite side of the station. This board embodies three rotary panels, one 1200 horse-power 480-volt motor panel, one 3000-ampère 480-volt power feeder panel, one auxiliary pump motor panel, and a three-wire lighting panel. We deal with the de-watering pump starting arrangements in the next paragraph, and may say here that, in addition to these large rotary converters, the General Electric Company supplied two further rotary converters of the same type, but of only 250-kilowatt capacity for No. 5 sub-station, under which heading they will be again referred to.

Graving Dock No. 6.

It will be observed from the plan, page 189, that there are no fewer than six graving docks, which vary in overall lengths from 280ft. to 912ft. All of them were originally equipped with steam de-watering machinery, though in the case of Dock No. 6 a 12in. electrically driven drainage pump was installed a number of years ago. It was the only electrically driven unit of the entire equipment. The largest dock is, of course, the Trafalgar, which, when it was constructed in 1903, was looked upon as being capable of taking in any vessel likely to use the port in the future. It has a length on the floor of 882ft., an entrance 100ft. wide, a depth of water over the sill at high water of spring tides of 35ft., and it contains when full some 100,000 tons, or, say, 22,000,000 gallons of water. The machinery to operate it is contained in what is known as No. 6 pumping station—see Figs. 4 and 5—and it consists of two de-watering pumps, one impounding or filling pump to raise the water level in the dock above that of the water outside—if and when it be necessary to do so—one house pump to keep the subsoil water from flooding the pump-room, two priming units, and one emergency hand-operated hydraulic pump for operating the pump discharge valves. Originally there were two 48in. steam-driven centrifugal pumps and one 45in. steam-driven impounding pump, all of them with horizontal shafts and all of Gwynnes make. Mr. Wauchope's specification provided that the new de-watering pumps must use the pre-existing suction and discharge pipes, and that each unit must be capable of pumping the dock dry within a period of four hours, with any condition of weather or tide, and with a maximum head of water above the grating over the suction culvert of 37ft. The impounding pump, it was specified, was to be capable of pumping into the dock 200 tons of sea water per minute against a static head varying from zero to 15ft. The two de-watering pumps were each to be continuously rated at 1200 brake horse-power, and the water ends were to be identical. They were, however, to be driven by motors of entirely different types. The motor of one was to be a three-phase asynchronous-synchronous machine, designed to run with a power factor capable of being adjusted by hand between the limits of unity and 0·9 leading, at full load.

It may here be explained, in passing, that a part of the agreement with the Southampton Corporation constitutes an undertaking on behalf of the Docks authorities to install, in the case of motors of over 200 brake horse-power, machines which would give a leading power factor, in consideration of which the Corporation agreed to charge the Docks for electricity on a kilowatt-hour basis, instead of on a kilovolt-ampère-hour basis.

The motor for the other pump was to be a direct-current machine capable of variation in speed to vary the water horse-power of the pump from 50 per cent. of its full load to 20 per cent. above its full load.

The actual machines supplied for de-watering are two standard "Invincible" centrifugal single-impeller dock pumps with cast iron double-inlet impellers, fitted with shrouded turbine-shaped blades. The impeller eyes are 41in. in diameter, while the diameter of the blading is 53in. and the angle of the blades 35 deg. The full load speed of both pumps is 231 revolutions per minute. The design of these pumps presented not a little difficulty to the makers on account of the high-water velocities which it was necessary to employ to get the desired speed of pumping, owing to the restricted cross-sectional areas of the inlet and discharge pipes. It will be remembered that the pipes used by the old pumps had again to be employed, for, since they were embedded in concrete, it would have been a very costly business to cut them out and replace them. The actual water velocity employed was, so we understand, nearly twice that used in normal practice, and when the pumps were first put to work the noise and vibration was considerable. However, we gather that alterations to cut-waters and impellers subsequently made by Messrs. Gwynnes reduced that trouble to a minimum. Each of these two pumps is designed to discharge at its full load, an average of 450 tons of water per minute against a head varying from 0ft. to 37ft., and their characteristic is such that they absorb very nearly the same amount of power throughout the range of head against which they have to operate. One of the pumps—see Fig. 7, page 198—is directly coupled to an English Electric Company's 1200 brake horse-power, 6600/6000-volt, 50-cycle, three-phase asynchronous-synchronous motor designed to give its output at 0·9 leading power factor, and to be capable of being adjusted by hand between that figure and unity. The other pump—see Fig. 8, page 198—is directly coupled to a 1200 brake horse-power English Electric 480/500-volt direct-current variable-speed open-type motor, designed to run at speeds varying from 210 to 245 revolutions per minute, and guaranteed to withstand an overload of 25 per cent. for two hours without undue heating. The alternating-current motor is fed directly from the extra high-tension mains through push button automatic control gear, and is believed to be the largest of its kind and voltage so far made and put to work in this country.

In operation, when the starting button is pressed, the machine starts as an ordinary asynchronous or induction motor, with a variable resistance in its rotor circuit, and runs up to synchronous speed, less

FIG. 4—INTERIOR OF NO. 6 PUMPING STATION FOR TRAFALGAR DOCK

the unavoidable slip. When full speed as an induction motor has been reached, an automatic change-over switch operates and transfers the rotor connections from the starting resistance to the exciter—which, it should be explained, is directly connected to the motor shaft—and the motor automatically pulls into synchronism and continues to run as a synchronous motor. The power factor is regulated as required by varying by hand the exciting current supplied to the rotor by the exciter. We deal with the motor starting arrangements in more detail in a subsequent article.

The reason for coupling one of the de-watering pumps to a variable-speed direct-current motor was to provide for slow pumping operations, which are sometimes necessary. The motor employed is a shunt-wound machine.

The impounding pump is similar in design to the main de-watering pumps, but its size and the power required to operate it are considerably less. It has blading. It is coupled direct to a 350 brake horse-power, 6600-volt, 50-cycle, three-phase, asynchronous-synchronous motor with a direct-coupled exciter—Fig. 6. The motor is designed to give its full power at 214 revolutions per minute and is in all respects, saving output and speed, similar to the 1200 brake horse-power alternating-current machine driving the main de-watering pump. It is also furnished with push-button automatic control gear of a type similar to that fitted to the motor already described.

In addition to the two de-watering pumps and the impounding pump, there is a house or sump pump, the office of which is to keep the engine-room dry. It is a standard "Invincible" single-inlet low-lift centrifugal pump with 3in. discharge and 4in. suction branches, and it is driven by a 7 brake horse-power 480-volt, direct-current, shunt-wound motor capable of a speed variation by shunt regulation between the limits of 1250 and 1350 revolutions per minute. The and 6in. suction branches, driven by a 15 brake horse-power, shunt-wound, direct-current, 480/500-volt motor with a normal speed of 950 revolutions per minute, but capable of variation between 900 and 1000 revolutions per minute. For use in conjunction with this pump there is a cast iron ejector with a gun-metal nozzle working in a tank.

The previously existing main pumps were fitted with hydraulically operated discharge valves. These valves were retained and ordinarily they are worked by water pressure obtained from the Docks hydraulic pressure mains. For use, however, in case that source of supply failed, the contractors had to supply a hand-operated power pressure pump, which is mounted on a tank. The contract also provided for the necessary piping and connections, as well as for the requisite pressure indicating instruments, &c., but it will not be necessary for us to describe them. It will suffice to say that the work has been carried out in a complete and eminently workmanlike character, as indeed was only to be expected with contractors, both main and sub, of such high standing.

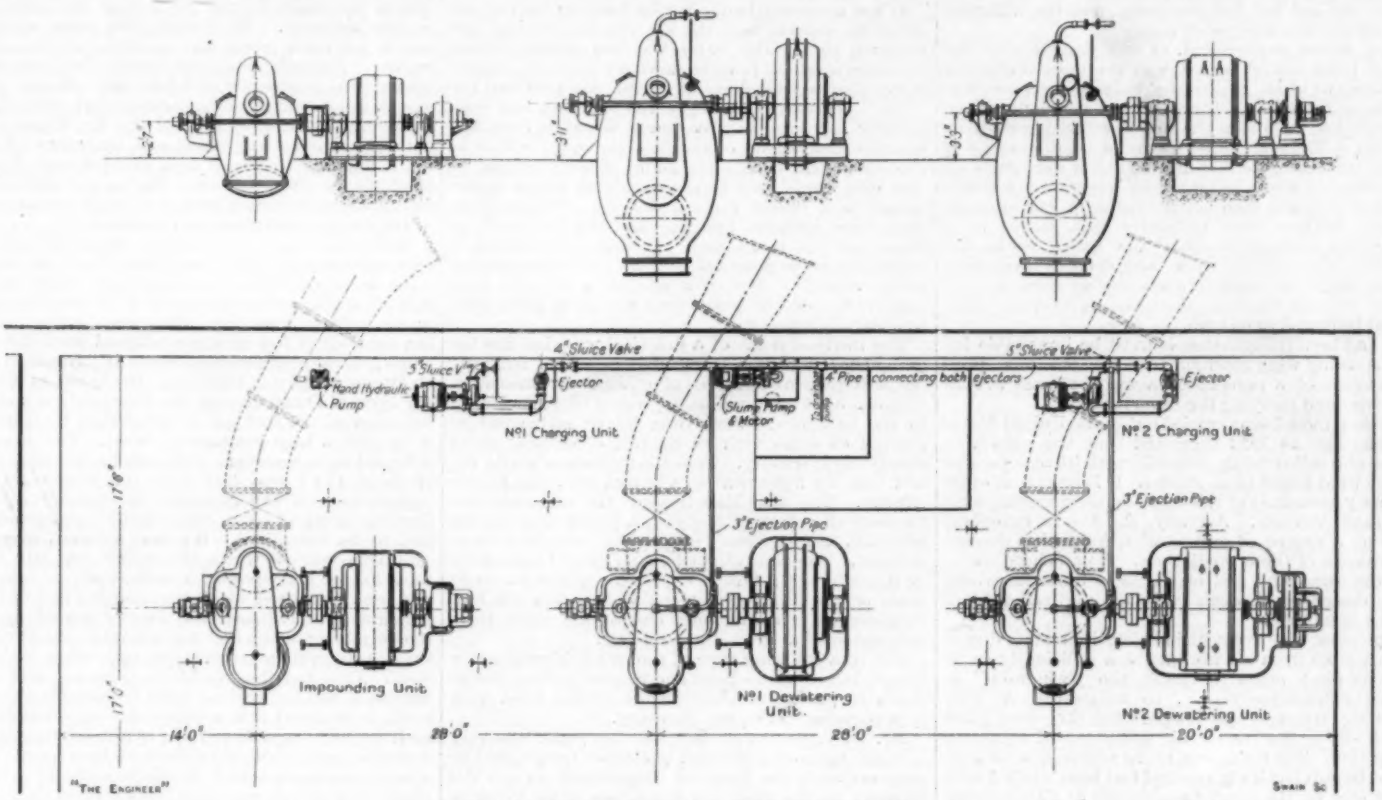


FIG. 5—ARRANGEMENT OF NO. 6 PUMPING STATION

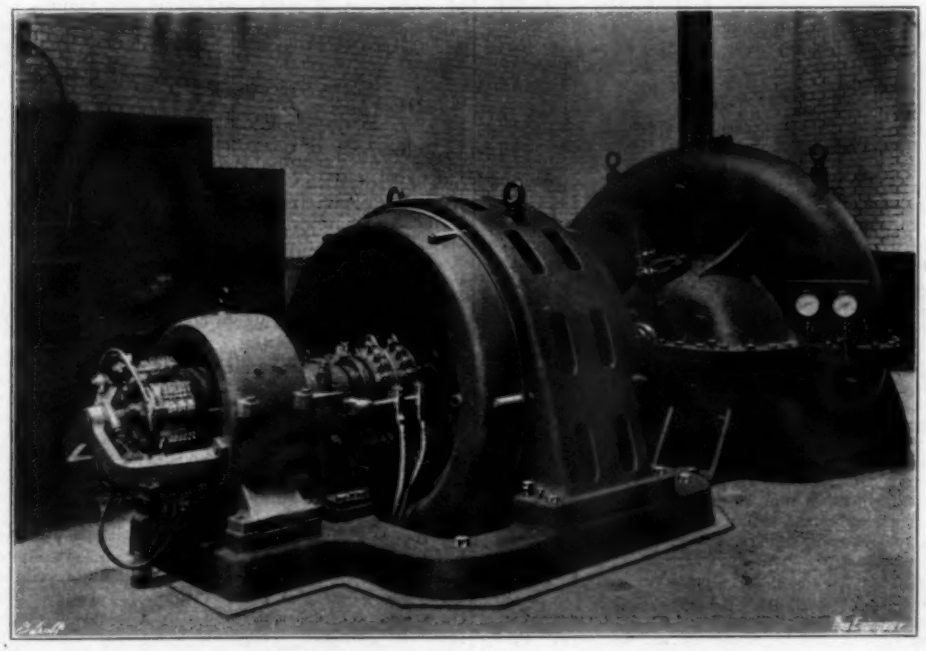


FIG. 6—350 H.P. ASYNCHRONOUS-SYNCHRONOUS MOTOR DRIVING IMPOUNDING PUMP

to deliver 200 tons of sea water per minute against a static head varying from zero to 15ft., or a maximum total gauge head from all causes of 16·5ft. The pump actually supplied was designed to pass 40,000 gallons of water per minute against a head of 14ft., the efficiency not being less than 70 per cent., with 250 brake horse-power on the shaft. The pump is a standard "Invincible" 45in. machine with an impeller having a diameter of 43in. and 35 deg. angle

12in. electrically driven drainage pump, which, as explained above, was installed some time ago, was retained, and was not replaced, as it was still in good working order.

For priming the de-watering sets in the event of that being necessary owing to the state of the tide, there are two Gwynne-Sargeant patented priming attachments. Each of these devices consists of a single-inlet centrifugal pump having 5in. discharge

British Association.

No. III.*

SECTION G.

AIRCRAFT DESIGN.

A GROUP of three papers dealing with various aspects of aircraft engineering was before the Engineering Section of the Association at Oxford on August 9th.

Mr. H. E. Wimperis, in a contribution dealing with the development of the rotating wing type of design, said that that invention had had a fascination for inventors for many years. It was the fact, however, he pointed out, that in spite of all their efforts very few machines sustained by rotating wings had flown as much as a kilometre. The American "Berliner," a fixed wing triplane with three lifting screws on vertical shafts, was one; possibly the American "Bothezat" was another; the European "Oemichen" and "Pescara" and "Cierva Autogiro" had also to be added to the list. The "Brennan" helicopter unfortunately met with an accident when attempting a flight. Few inventors in this field had seen the problem as a whole; usually they had thought only, or almost only, of the requirement that the rotating wing must provide sufficient lift to carry the load. There were, however, two other requirements, at least as important, and a good deal more difficult to meet. One was that the aircraft must be controllable in flight, and the other that a safe descent must be ensured when the power unit was out of action.

Any competent designer of air screws could provide a scheme for giving adequate "lift" in either an airplane or a helicopter structure. But when, as in the latter type of craft, the lifting screw was spinning on a vertical shaft whilst the craft as a whole was in horizontal motion, a special difficulty

* No. II. appeared August 13th.

arose in that the blade which was instantaneously moving in the direction of the horizontal motion had a higher air speed than the retreating blade, and had therefore much more "lift." This inequality gave rise to a most inconvenient overturning couple which tended to make the aircraft difficult to control, and led to heavy structural stresses. There were mechanical ways of countering this tendency. Cierva hit upon the neat plan of hinging the blades, so that each could rise and fall independently, and the difficulty was simply and adequately met.

The second requirement, of safe descent with the power plant out of action, was the most important requirement of all, and to the designer had proved to be the most baffling. The view very commonly taken hitherto had been that the engine would normally be driving a lifting air screw having a positive angle of pitch, and that once that driving power were removed the tendency would be for the air screw to slow down, come to rest and then begin rotation in the opposite sense. With a pure helicopter that would be a dangerous manœuvre, since the speed of descent would rise to a high value, and even if there were ample height in which to allow the air screw to pick up its reverse rotation, the ultimate vertical speed would be bound to be high.

It had been thought that it must be impossible for any rotating wing machine to rival the low speed of descent of a parachute having the same overall diameter and carrying the same load.

Certain model tests carried out in the United States as long ago as 1922 suggested that the parachute effect of a self-rotating propeller with its axis parallel to the wind might be as much as 1·7 times that of an ordinary parachute of the same diameter moving with the same velocity. Actually, the Cierva gyroplane showed a degree of sustentation in vertical descent in advance of those predictions. A parachute carrying the same load and of the same diameter would have descended through twice the vertical distance in the same time.

One great improvement in safety in landing due to Cierva arose from his working at a sufficiently small positive-pitch angle to enable the "windmill" to rotate automatically—*i.e.*, to autorotate—at substantially the same speed, even when the power plant which drove the tractor air screw ceased operation altogether. The conditions under which such rotation could be automatically ensured had been studied with great care by the aerodynamic staffs at Farnborough and Teddington. Reports on the results of the work carried out by those staffs would doubtless be issued in Aeronautical Research Committee publications in due course.

The plan of hinging the wings of the windmill so that they oscillated in a vertical plane during each rotation, thus presenting an analogy to the flapping flight of birds, appeared to have first occurred to Cierva in 1922. The wings were prevented from folding up about their central hinges by the centrifugal force due to the rotation. In the following year, 1923, the first gyroplane flight—one of four minutes' duration at a height of some 25 m.—was carried out in a closed circuit. The machine, as initially designed, had two remarkable characteristics. First, that the windmill rotated in the opposite direction to that which would generally have been expected, and, secondly, the vertical speed of descent when the engine was stopped was remarkably small. The four windmill blades were set at a pitch angle of opposite sign to that of an ordinary windmill. That at first might seem puzzling, but the reason was best grasped by considering what happened to a gyroplane when it was descending vertically in still air. The motion of the air relative to the blades was then made up of the peripheral speed combined with the vertical speed of the windmill relative to the air through which it was descending. The resultant had an angle to the horizontal depending upon the ratio of the vertical speed to the peripheral speed. The lift force on the blades would be at right angles to that relative wind, and the drag force would be along it. The resultant of the lift and drag was a force sloping behind the lift line, and if the blades were mounted on a vertical axis the angle between the resultant and that axis would depend upon the lift-drag ratio of the specific wing section employed. If the resultant was tilted forward, relative to the axis, there would be a component force hastening the rotation of the windmill, whereas if it were tilted backwards there would be a retarding force. There was therefore a critical speed of rotation which, when exceeded, built up automatically, but which, if not attained, was followed by the gradual cessation of rotation when the driving effort was relaxed; hence, if the wings were brought up to some given speed, they might accelerate or decelerate, depending on what that speed was, but once they passed the critical angular velocity they accelerated to a steady state.

As usually happened in aircraft design, a compromise had to be made between conflicting claims, and it was not possible to lay down formal rules for arriving at such decisions. In rotating wing machines, the first thing to settle was the permissible speed of descent; the next point was so to relate the parts as to ensure the automatic provision of a sufficient rotational speed, backed by an available restoring torque of "comfortable" dimensions, to ensure that a chance reduction of rotational speed should not lead to stoppage. The margin of safety was usually considerable, since, while the great angular momentum would maintain the speed of rotation during any ordinary evolution, any small reduction in rotational speed led to a corresponding reduction in lift, and therefore an enhanced velocity of descent; the relative vertical air velocity due to that would increase the relative mean angle of incidence, and therefore tend to restore the rotational speed to its former value.

It was necessary to distinguish between the vertical speed for descent and the air velocity through the windmill disc. The latter was the smaller figure, since the windmill brought down air with it; in fact, it was that beating down of the air that provided the "lift." In horizontal flight the windmill was continually operating in what might be called fresh air, and the relationship of the flow through the disc to the component of the horizontal velocity normal to that disc would be different from that which appertained to a purely vertical descent. The relationships were complex, however, and the last word on them had yet to be said. It was, nevertheless, a matter of great practical interest that experimental work seemed to show that as slow a descent, with engine off, could be made down a vertical flight path as along a sloping one.

The mode of flight of a practical machine like the gyroplane afforded a convenient means of studying the performance of all types of rotating wing machines. In that way it was possible to proceed from the known to the unknown, rather than by an endeavour to proceed *ab initio* with an aircraft of entirely novel aerodynamic quality. That the gyroplane would fly, and that its flight was steady and safe, was known already. The next step towards the unknown was to study the effect of applying a power drive to the windmill, at first when "getting off," and later when in flight. The issue might be a successful helicopter, or it might not; but in any case exploration could cease at the form of machine which gave the best combination of advantages, and at the worst there still remained a successful gyroplane.

The rotating wing type of aircraft evidently had a future, but to what extent and in what fields it would prove to possess an advantage over the fixed wing type remained for future discovery.

Mr. R. V. Southwell said that the paper was very stimulating to all interested in aircraft design, and he congratulated the Research Department of the Air Ministry on the attention which was being given to the autogyro and on the manner in which the problem was being attacked from the aero-dynamical side. His own idea about the new design was that it was likely to be more useful for seaplanes than for ordinary aeroplanes. From some aspects the advance which the new machine represented was of a remarkable character.

Professor Jenkin asked how the controls were arranged for bringing the machine vertically downwards.

Mr. A. C. Thurston agreed as to the outstanding character of the invention dealt with in the paper. The method of pivoting the blade so that the centrifugal forces balance the lift was wonderful. The machine presented a combination of an aerodynamical and structural problem. It had been studied by British designers for many years. George Cayley was one of the first to realise the advantages associated with hinged wings, and Hiram Maxim was fully aware of the advantages which could be gained by construction of that character. Experiments had been carried out both at Farnborough and at the National Physical Laboratory. Model aeronautical engineers had constructed models which had been flown with very great success. The advantages of the hinged wing were therefore well known. It would add to knowledge of the subject if more model tests could be made with models constructed by practical men who were keenly alive to the structural difficulties which had to be overcome in the application of the hinged wing to full-scale aircraft. He agreed that in the case of the rotating screw the structural difficulties were greater than those arising on the aerodynamical side.

Mr. Wimperis, in reply, referred to work that had been done to ascertain if any advantage could be gained by putting part of the power of the engine in the wing, and stated that for the gyroplane there was no advantage in such an arrangement. It might be different in the case of the helicopter. He quite realised that the new design was more suitable for the seaplane, but it would be desirable to give attention to the provision of an adequate self-starter to shorten the time of taking off from the water. The autogyro would also be a suitable machine for use in countries having large tracks of land with a paucity of roads, and where the loss of mileage covered in a given time would be relatively unimportant. Pilots could learn to drive a machine of this type very easily, and the safety in landing would be a great advantage. Professor Jenkin had asked about vertical descent. It should, he thought, be possible to design a machine for absolutely vertical downward motion, but it could not be done with the existing methods of control.

Compression Ignition Engine.

Mr. D. R. Pye introduced a paper in which he gave an account of recent work directed to the development of an engine burning heavy oil for use in aircraft. He said that the idea of a compression-ignition engine using heavy oil had certain obvious attractions for aeronautical engineers. The advantages to be gained by sweeping away all the complications of electrical ignition, by the use of a cheaper fuel at a higher thermal efficiency, and by the reduction of fire risks, were indeed worth striving for, and it was not until the attempt was made to cut down the price, measured as weight per horse-power, to a point within the limits for air work that the difficulties became apparent. At present, the price asked in weight per horse-power was too high for the aircraft builder. Nevertheless, great strides had been made towards the production of a light and efficient prime mover using compression ignition, and even if the research work done by and for the Air Ministry had not yet succeeded in putting such an engine into the air, it might all the same be a national asset if made available for other purposes. He was not able to give full details of the latest work, but could indicate some of the results which had been attained.

With the object of exploring the possibilities of compression-ignition working rather with the view to using an engine of that type in airships, work was put in hand at Farnborough and also at Messrs. Ricardo's works. They were not duplicated researches, as the methods of fuel injection adopted were different. Some general considerations arose in connection with an aviation engine of this type. In the heavy stationary type of Diesel engine, the pulverisation and distribution of the fuel was accomplished by squirting it in with a high-pressure air blast. The economy achieved in such engines, with their compression ratio of about 15 : 1, was very high, but the weight and complication of the necessary air compressors put them quite out of court, where weight and simplicity had to be considered. On that account, even for submarine engines where the weight was still 30 lb. to 40 lb. per horse-power, a method of fuel injection had been developed which was independent of high-pressure air. Reliance was largely placed for the proper mixing of the fuel and air upon either turbulence in the cylinder or upon the penetration of the jet itself. Provided that satisfactory mixing and combustion of the fuel and air could be brought about, it could be assumed that a compression-ignition engine with its high expansion ratio might be expected to consume a smaller weight of fuel per horse-power than a petrol engine, and since the effective weight of power plant for an aeroplane, which had to get off the ground fully equipped with fuel, was the total weight of engine and fuel, any reduction in the fuel weight necessary for a given journey might be set off against an increase of weight in the engine itself. The longer the journey the more would high fuel economy compensate for a heavier engine. Allowing for that factor, it could be claimed that at a weight of 3 lb. per horse-power, the compression-ignition engine would be a serious proposition for heavier-than-air craft, and could compete with the petrol engine at a weight of 2 lb. per horse-power.

That position had not, of course, yet been reached. It should be borne in mind that the petrol engine at 2 lb. per horse-power maintained a brake mean effective pressure of 130 lb. per square inch up to speeds of revolution of 2000 revolutions per minute and higher, corresponding to mean piston speeds of about 2300ft. per minute. The highest output obtained with direct injection engines in commercial use was of an order corresponding to a B.M.E.P. of 70 lb. per square inch at piston speeds of 1500ft. per minute. Those figures indicated the magnitude of the problem to be faced, for the only hope of reducing the weight-power ratio of such an engine to within the range of possibility for air work must involve an increase of the mean piston speed to about 2000ft. per minute while maintaining at the same time a brake mean effective pressure of at least 100 lb. per square inch. At those speeds the time available for injecting and vaporising the fuel became exceedingly short, and a host of difficulties was encountered in the attempt to obtain reasonably complete combustion of both fuel and air.

The problem which had to be solved was the attainment of the necessary mean effective pressure in conjunction with a controlled maximum pressure and the employment of a cycle in which, after the first part of the fuel had been burnt at constant volume, combustion of the remainder occurred at as near the agreed maximum pressure as possible. The problem which the single-cylinder research worker set out to investigate was what maximum output, measured as (B.M.E.P.) × (mean piston speed), there was any hope of attaining from a compression ignition cylinder with a reasonable bore/stroke relation, the maximum pressures being also limited to allow of light construction. Combustion in a direct-injection engine involved a number of chemical and physical problems of the greatest interest and variety, which presented a wide field for further research. It was necessary, in the first place, to form a fuel jet which would deliver a definite quantity of fuel during a predetermined time interval, and, while doing so, would penetrate the compressed gas sufficiently to give adequate mixing of the fuel and air. Combined with that penetration there must be sufficient breaking up, or "pulverisation," of the fuel to promote its vaporisation and combustion in the extremely short time available. Those problems immediately raised the question of the dependence of the penetration of a

jet and of its pulverisation upon the delivery pressure, upon the pressure, density and temperature of the gas into which it was squirted, upon the constancy of fuel pressure during delivery, and upon the design of the nozzle. Researches on jet formation had been carried out by Riehm and by Miller and Beardsley. There were two methods of producing the necessary fuel jet. In one system, an approximately constant pressure was maintained in the fuel supply in the immediate neighbourhood of the injection valve, and the admission of fuel to the cylinder was controlled by the opening and closing of that valve by a cam and spring in the usual manner. There were certain advantages in a constant injection pressure, and in that method, moreover, the beginning of injection was controlled in a very positive manner. It was with that system that the best results, on a single-cylinder unit, had so far been obtained.

In the other method, the "jerk pump" system, the admission of fuel to the cylinder was controlled by a spring-loaded valve which was opened and closed by the rise and fall of pressure in the oil fuel itself. There was, however, a variety of problems involved in jerk pump injection which only long and careful research could solve sufficiently to place the designer on firm ground in judging the characteristics of his jet. The difficulties inherent in the otherwise advantageous alternative, of opening and closing a valve which admitted fuel under approximately constant pressure, arose from the necessarily very small and very rapid movement of a robust valve spindle.

Certain tentative conclusions could be stated as the result of the research work which had been in progress. As far as he was aware, no multi-cylinder engine of the compression-ignition type had yet been built at anywhere near 3 lb. per horse-power, although a two-cylinder unit of the "Attendu" engine came out at about 4 lb. per horse-power. The fuel consumption in it was, however, 0·6 lb. per brake horse-power, and unless that figure could be largely improved upon, an engine even at 3 lb. per horse-power could not compete with the petrol engine for heavier-than-air craft. The single-cylinder work had shown that it was possible, nevertheless, to obtain a cylinder output expressed as (B.M.E.P.) × (piston speed), or, in other words, as horse-power per square inch of piston area, nearly on a level with that of a high-duty petrol engine, and that that could be done without going more than a little beyond the maximum pressures customarily allowed for, and with a considerably lower fuel consumption. To get the piston speed, a large cylinder was desirable in order to keep down the revolutions, and that would involve some increase of weight in crank shaft and crank case construction. But even allowing for that it should be possible, if the performance obtained with a single cylinder could be reproduced on a complete engine, to keep the weight/power ratio within the limit of 3 lb. per horse-power. The design difficulties of reproducing those research results in a multi-cylinder engine were, however, very formidable. If the successful R.A.E. method of fuel injection was to be applied on a complete engine, the problem had to be faced of carrying an overhead cam shaft in a sufficiently rigid cylinder head construction to give the very small lift and the precise timing, accurately and continuously, on a series of cylinders. The weight could possibly be reduced by the development of the two-stroke cycle engine.

His main object in dealing with what was being done by research and experiment was to bring to the notice of engineers generally what could be done in the design of a high-duty engine using compression ignition of a directly injected liquid fuel. For a variety of purposes, that type of engine offered great possibilities of development, both as regarded fuel economy and the saving of weight in material. But only by the closest attention to the fundamental conditions of jet formation and combustion would it be possible to achieve the economy which should go with the high-expansion ratio. The engine was a striking example of a field of investigation in which the designer was really waiting upon the research worker to give him guidance on the intimate details of his work.

Sir Dugald Clerk welcomed the paper as giving an interesting account of the present position of the work of evolving a compression-ignition engine for aircraft. Referring to the diagrams given, as long since as the year 1888 he had published something of a similar character. His diagrams were indeed the same as those obtained by Diesel. He had been much impressed by the high efficiency of 38·8 per cent. which had been obtained in recent work. Personally, he had always thought it should be possible to obtain a brake thermal efficiency of about 40 per cent. With regard to the effect of turbulence, he thought that that phenomenon might be used in a directive manner to give the mixture required very quickly or use might perhaps be made of power from another source to get the right mixture of air and sprayed oil.

Professor C. F. Jenkin congratulated Mr. Pye on the clearness with which he had stated the problem, and set forth the essential points.

Mr. H. P. Tizard welcomed the attempt which was being made to develop a compression ignition engine for air work, as even if it did not succeed something would be achieved which would be of use from the commercial standpoint. It would be a useful addition to the valuable information given in the paper if Mr. Pye would state the oil as well as the fuel consumption. He would also like to have the opinion of the author as to whether there was any possibility of considerable weight reduction by having recourse to the two-stroke cycle.

Wing Commander Cave-Brown-Cave referred to the question of the fire risk associated with using oil of a flash-point different from petrol. Referring to the general question of aircraft design, his experience indicated that the chief troubles arose in connection with the magneto and the carburetters, and he had fears that with the compression-ignition engine some trouble might arise from the method of fuel injection. His own reading of the paper was that the solving of what was essentially a physical problem was the next step. He referred to the control of operations within the cylinder. There was a factor of uncertainty arising in connection with the time it took the fuel to burn after admission to the cylinder. It was necessary to speed up that operation.

Sir James Henderson dealt with the weight per horse-power aspect of the engine design, and pointed out that while weight went up as the cube of dimensions, horse-power only increased as the square of dimensions. A factor independent of dimensions was wanted, and perhaps attention to the subject would enable a new factor to be introduced. Horse-power divided by the square of the diameter might be suggested, but that was a factor which would vary, of course, with the ratio of stroke to diameter.

Sir Henry Fowler referred to the question of weight and relative cost of engines. The cost of the light-weight engine often went up owing to the material which had to be removed to get lightness. That was, he said, a point of considerable importance from the commercial standpoint.

Mr. Pye, in concluding the discussion, said with regard to Sir Dugald Clerk's suggestion to fit what would be an auxiliary mixing chamber, that it all came down with an aircraft engine to the question of weight and simplicity of construction. Those considerations militated against the use of an auxiliary device for pre-mixing. Perhaps for aircraft work it was problematical if a satisfactory compression-ignition engine could be worked out, but from the ordinary commercial standpoint it was worth while going ahead with the experimental investigation. With regard to the additional safety which would be attained if an engine of the type under discussion could be used for aircraft, that was of more importance for commercial than for service machines. The saving in cost of insurance by a reduction of the fire risk would be important in the case of companies engaged in the commercial air transport business. He regretted that he was unable to give the figures for the oil consumption of the experimental engine. He agreed that at the present time the urgent problem which should be attacked was that of speeding up the process of combustion of the fuel. If something could be achieved to solve that problem, it would be a great step forward.

Corrosion of Aluminium.

Mr. H. Sutton gave an abstract of a paper by Dr. G. D. Bengough and himself dealing with the protection of aluminium and its alloys against corrosion by anodic oxidation.

He pointed out that the resistance of aluminium to corrosion was undoubtedly due to the presence of a protective film of aluminium oxide or hydroxide. It would seem therefore that the resistance of aluminium against corrosion might be greatly increased if a thick and strongly adherent film of oxide or hydroxide were formed on the metal instead of the natural thin film. Mott had shown that such a film could be formed by making the metal the anode in a bath of sodium-hydrogen phosphate, and recommended such treatment as a protection against corrosion. The authors found that the film produced by anodic oxidation in a bath containing a chromate, bichromate, or, best of all, chromic acid, protected the metal much more effectively. The process of anodic oxidation was essentially as follows:—After thoroughly cleaning the surface of the aluminium, it was immersed in a suitable bath, *e.g.*, dilute chromic acid, along with a carbon rod, and a small external E.M.F. was applied so as to make the aluminium the anode and the carbon the cathode. The applied E.M.F. was gradually raised to a value depending on the nature of the alloy and on the composition of the bath. Thus, with duralumin in a chromic acid bath, the pressure might be safely raised to 50 volts. After treating it for some time in this manner, the surface of the metal became covered with a semi-opaque, uniform, grey coating.

In carrying out the treatment, two practical points should be noted. The immersed material must consist only of aluminium or suitable aluminium alloys, since other commercial metals were usually attacked by the treatment; also, the bath should be large compared to the material, otherwise the heat produced by the current would make it difficult to regulate the temperature of the bath. However, in cases in which a sufficiently large bath was impracticable, cooling coils might be used to remove the excess of heat.

The coating seemed to consist almost entirely of aluminium oxide in a glassy, adherent form. The film would form in the recesses of any pores or cracks in the metal, provided the liquid could penetrate into such pores and cracks. That was a property of great importance as a protection against corrosion.

A preliminary study of the anodic oxidation process was carried out by treating a large number of specimens under different conditions. The number of variable factors was obviously large, *e.g.*, the nature of the alloy, the composition of the bath, the time of treatment, and the maximum voltage applied. For simplicity, sheet duralumin was mainly used for the tests, and attention was concentrated on determining the type of bath which gave the best coating. Pitting was due to breakdown of the protective coating under electrical pressure, and the voltage at which it occurred was known as the "breakdown voltage." It was dependent mainly on (1) the nature of the metal treated, and (2) the nature of the bath.

When pitting began under the anodic treatment through breakdown of the glassy coating at one or more points, the current rapidly increased, and the metal was heavily attacked at such points. The oxide produced under those conditions over the pitted area was apparently a non-protective porous variety, instead of the original glassy form. The experiments indicated that the best coatings could be obtained in a bath consisting only of a solution of chromic acid, and that pitting could be avoided by suitable voltage regulation. The chromic acid used contained 0·95 per cent. of sulphuric acid, that being the purest material available in sufficient quantity to make up the solution.

The anodic process provided a protective coating at pores and cracks, but water-line conditions broke down even the anodic film. Clearly, some form of waterproofing was desirable in order to prevent gradual penetration of the film as a result of wetting and drying. The simplest method of waterproofing was to apply a grease, such as lanoline. That might be effected by dipping the article in molten lanoline or in a solution of lanoline in a suitable solvent, *e.g.*, a 15 per cent. solution in benzene, or into a lanoline emulsion. The lanoline was adsorbed by the film and held very tightly. The resistance to corrosion of anodically-treated aluminium and aluminium alloys was much increased by the lanoline. The film could also be waterproofed by the application of paint or varnish. The combined treatment gave very effective protection against corrosion, and was much superior to treatment by paints and varnishes alone, for they adhered much more strongly to the thick oxide film than to the untreated metal.

The results of what had been done went to show that the treatment substantially increased the corrosion resistance of aluminium and its alloys. The application of the process to which the authors had given first consideration was the protection of aluminium and light alloy aircraft parts. The main corrosive influences to be considered in aircraft were sea water corrosion and atmospheric corrosion. Aircraft flying inland within 40 miles of the coast might be in an atmosphere of salt spray, the effect of which on aluminium and aluminium alloy components was serious. On marine aircraft the prevailing conditions were very severe. Sea mist, spray, splashing of sea water, and sea water remaining on the aircraft in the sheds of seaplane stations, all tended to give the equivalent of water-line conditions under which corrosion took place very rapidly. Under these severe conditions, anodic oxidation followed by lanoline treatment had been found to afford satisfactory protection over considerable periods.

Professor C. F. Jenkin said that during the war period the uncertainty which existed regarding the corrosion of the aluminium alloys led to a discontinuance of the use of duralumin for aircraft construction. As a result, however, of the knowledge which had since been obtained, that alloy was now being used in aircraft to a considerable extent.

Professor Thomas Turner congratulated the authors on the work done. It was well known that when heated in air aluminium had formed on it a thin protective film, and Dr. Bengough and Mr. Sutton had sought for a method of obtaining that film by a cold process. It was very interesting to find that that could be done by using a solution of chromic acid. To give adequate protection, it was necessary that the coating should adhere very closely to the metal, and in some other cases in which a protective film was required, it had been found an advantage to sand blast the surface to make the adhesion of the coating more complete. The process described resembled that used in the case of a protective coating of phosphate of iron, which was not, however, always perfect, and a better result was obtained by oiling the surface afterwards with a form of japan. The authors had also employed a second process of finishing off with lanoline. He had been closely associated with the work on corrosion when it was carried out by the Committee of the Institute of Metals. It had been found in the course of the work done at that time that the most exacting test of resistance to corrosion which could be made was to fasten the specimens to the pier of a seaplane station, half way between high tide and low tide in a position in which the samples were alternately wet and dry. The results of the research described in the paper were eminently satisfactory from the practical point of view. The method of protection was very simple, and apparently effective, and it could be applied, he imagined, on a large scale for girders of the type used in airship construction. That in itself was an achievement of considerable value. Another point was that corrosion arising from scratching would not be so serious with

the treated metal as if it had been left in an unprotected condition.

Professor W. Cramp commented on the fact that Dr. Bengough and Mr. Sutton had obtained better results when using chromic acid than had been got with alkaline solutions. He was particularly interested in the process from the point of view of the protection of overhead electrical conductors, but feared that the coating would break down at a lower pressure than was used in electrical transmission systems. Perhaps it would be possible to improve the process to enable the pressures used on overhead lines to be met without breaking down the protective film. Reference was made in the paper to a non-protective porous form of oxide, and that was a point of considerable importance, which should receive further investigation.

Professor F. C. Lea also referred to the non-protective oxide produced under certain conditions, and the need of preventing its occurrence. Excellent work had, however, been done in enabling the alloys of aluminium to be used in aircraft construction. He noted from the results of the bending tests quoted that the process had reduced the bending characteristic of the material, but that perhaps was not so important as might appear at first sight, as any necessary bending of the material would probably be done before it was treated for corrosion. One effect of the treatment was to remove the $CuAl_2$ from the surface of the material, and that perhaps explained the falling off in bending qualities. He would like to know whether the treatment with lanoline was really necessary when the anodic process had been applied, and also whether the application of lanoline alone had been tried. It was not unlikely that the lanoline would have a good effect on the spots where the anodic process led to the formation of the non-protective porous coating.

Mr. D. R. Pye said that the work done was an example of research of real commercial value which had been carried out entirely by Government aid. Dr. Bengough had made the investigation at the College of Science and Technology with the assistance of a Government grant, and the importance of the work had been at once recognised by Mr. Sutton and his collaborators at the Royal Aircraft Establishment. The direct commercial application of the process had indeed reached the point when Mr. Sutton had been inundated with requests from aircraft constructors to treat metal in the bath now available at the Government establishment.

Mr. Sutton, in a brief reply to the discussion, said that there was no advantage to be gained by sand blasting the metal. For aircraft parts the most severe test was sea water immersion at about mid tide. With regard to Professor Cramp's request for a protective film which would not break down under high electrical pressures, such a development might be possible, but he did not see at the moment how it could be done. The degree of purity of the metal was an important point. With regard to the period over which the treatment gave protection from corrosion, about twelve months was a fair average. Untreated samples were completely corroded away in that time. With regard to the non-protective porous variety of coating, he was not in possession of all the facts. There were very few aluminium castings produced which did not contain surface defects, and it could be said that the anodic treatment gave satisfactory protection of the unsound metal. The question of porous aluminium castings was for the metallurgist and was outside the scope of the paper. It could be claimed that as far as the alloys mentioned in the paper were concerned, the process described had proved successful.

Models and Analogies for Demonstrating Electrical Principles.

No. II.*

To illustrate the principle of synchronous and induction motors Mr. J. F. Gill, of the Bootle Technical School, employs apparatus constructed on the lines shown in Fig. 14. There are three parallel iron wire cores wound with double cotton covered wire and mounted in a frame at the corners of an equilateral triangle, and a movable pivot is mounted in the centre of these cores at the upper ends. The leads to the three coils are brought out to six separate terminals on the base, so that by connecting three of the terminals to a three-phase supply and by joining the other three together a rotating field is obtained, and it can be made to act upon a compass needle placed in the centre of the top of the apparatus, thus illustrating the action of the synchronous motor, whilst by placing the pivot in position and mounting a copper disc upon it the principle of the induction motor is shown, for in that case the rotation is produced by the action of the induced currents in the disc. Similar arrangements are, of course, frequently employed for explaining the action of alternating-current motors, but this particular model was constructed in accordance with Mr. Gill's own ideas.

A primitive sort of hot wire ammeter is also used by Mr. Gill, and is made up on the blackboard in front of the class in a few minutes. A piece of No. 28 nickel-chrome wire about 4ft. long is fixed horizontally to the board by means of two drawing pins, as shown in Fig. 15. A second length of wire about 2ft. 6in. long is tied to the centre of the horizontal wire and its lower end is pinned to the board so that it is vertical. A piece of string is tied to the centre of this vertical wire and passes round a light pulley on the board, and to the free end of the string a small weight is attached so as to keep the system taut. A paper index is clamped to the pulley and a scale is drawn on the blackboard with chalk. This simple hot wire ammeter is calibrated with a standard instrument, and the pointer usually deflects through about 60 deg. per ampère. Experience has shown that the students realise the principle of the hot wire ammeter from this rough model much more readily than they do from the actual standard instrument, and by putting paper riders on the wires they can see the amount of sag produced by the current. Moreover, as the wire is readily cooled by a draught they appreciate the necessity of providing a base with the same coefficient of expansion as that of the wire.

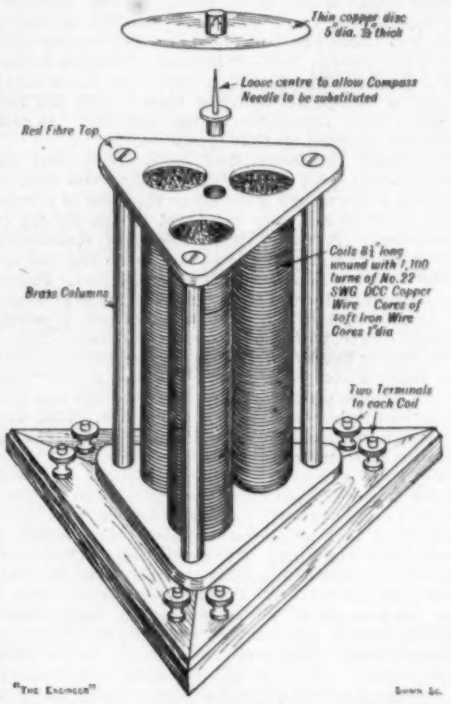

Thin copper disc 5" dia. 1/8" thick
Loose centre to allow Compass Needle to be substituted
Red Fibre Top
Brass Columns
Coils 8½" long wound with 1,100 turns of No. 22 S.W.G. D.C.C. Copper Wire. Cores of soft iron Wire Cores 1" dia
Two Terminals to each Coil
"The Engineer"
Swain Sc.

FIG. 14—APPARATUS FOR DEMONSTRATING PRINCIPLE OF SYNCHRONOUS AND INDUCTION MOTORS

A similar experiment was shown to us some time ago by Mr. W. C. S. Phillips, of the Borough Polytechnic. In that case, however, a steel wire, about 20ft. long, was stretched across the class-room as shown in Fig. 16, the free end being weighted and attached to a pointer. The expansion in this case was naturally very pronounced. Mr. Phillips also brought several other experiments to our notice. A lamp, for instance, was placed in a direct-current magnetic field and the effects of feeding it with direct and alternating currents were demonstrated. When alternating current was passed through the lamp the filament was set into rapid vibration. Another of Mr. Phillips' experiments is designed to show the action of a direct-current motor. Between the poles of a powerful electro-magnet a loop of wire is placed as shown in plan in Fig. 17, the loop being free to move. On passing a current through the wire the loop moves upwards out of the magnetic field.

One of the most difficult matters to explain to elementary students and non-electrical people is the meaning of the term "power factor." A perusal of text-books indicates that most teachers avoid the use of analogies, but many attempts appear to have been made to explain by hydraulic and mechanical means the object of making consumers of alternating current pay an increased price for their current when the power factor of their installations is low. The following analogy, which has been taken from the Electrical Apparatus Company's power factor booklet, has been invented for this purpose, and not with a view to helping students of electrical engineering, who are naturally more deeply concerned with the true meaning of power factor. In Fig. 18 the motor is replaced by a rather peculiar water wheel, having only two buckets, the power mains by pipes, the current waves by waves of water, and the power house by a pumping station, which is supposed to circulate the water in the form of waves. To make the best possible use of such an arrangement the water wheel must rotate, so that every time a wave comes out of the supply pipe the whole of it falls into a bucket on the wheel, thus giving the wheel a push round. Let it be supposed that if 1 gallon of water be put into each bucket as it passes the supply pipe the wheel gives 1 horse-power. Each wave in the supply pipe must therefore contain 1 gallon of water for the machine to give 1 horse-power, that being taken to represent the case of unity power factor.

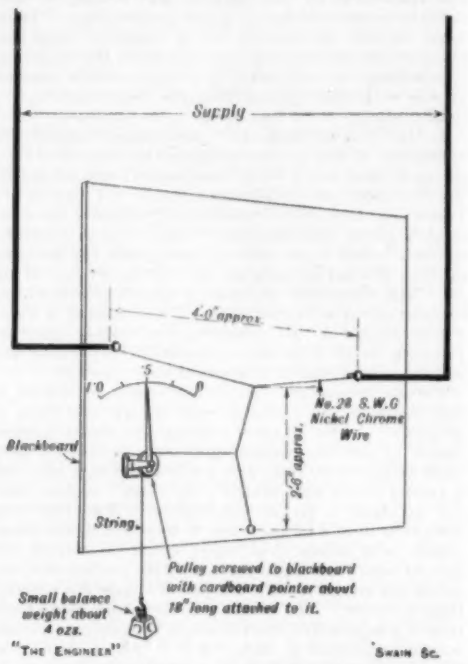


FIG. 15—ARRANGEMENT FOR DEMONSTRATING PRINCIPLE OF HOT WIRE AMMETER

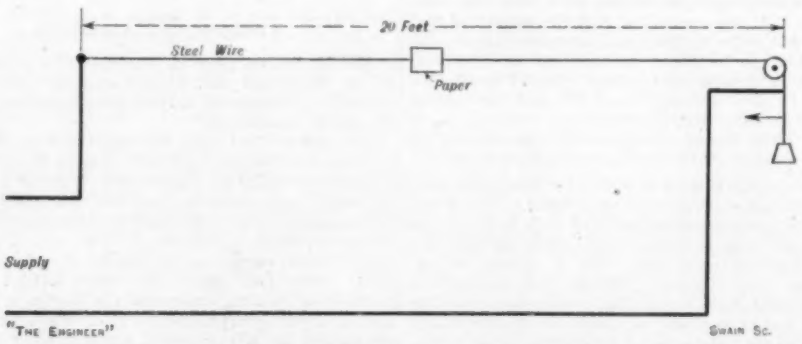


FIG. 16—EXPERIMENT SHOWING THE EXPANSION OF A WIRE CARRYING AN ELECTRIC CURRENT

Another case is shown in Fig. 19, in which the water wheel is rotating at the same speed as before, but in this instance the buckets are not immediately under the supply when the wave issues from it, a percentage of the wave—25 per cent.—being in this case lost. Only 75 per cent. of the total wave will therefore do useful work on the wheel. Thus, in order that each wave may put 1 gallon of water into each bucket, the waves must each contain 1⅓ gallons, when the machine will still give 1 horse-power, but more water is circulating in the system. As only 75 per cent. of the water supplied is usefully employed, this represents a power factor of 0·75, or 75 per cent.

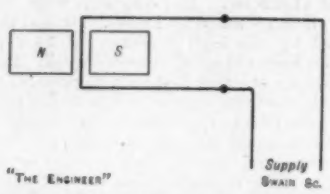


FIG. 17—EXPERIMENT SHOWING PRINCIPLE OF ELECTRIC MOTOR

A meter measuring the units taken by an ordinary motor only measures that part of the current that is usefully consumed; but it is evident from this illustra-

* No. I. appeared August 13th.

tion that the power station has to supply an extra current which does no useful work, and that necessitates the employment of larger mains or pipes, in the case of the water wheel, thus increasing the capital outlay and transmission losses, with a consequent increase in the cost of production. This analogy has been given by Mr. W. R. Cox.

Another, by Mr. L. Dalton, utilises a fixed wheel cycle. Imagine that a cyclist on a machine of this type is propelling himself forward by exerting an even pressure on each pedal alternately from its highest to its lowest position. Useful work will

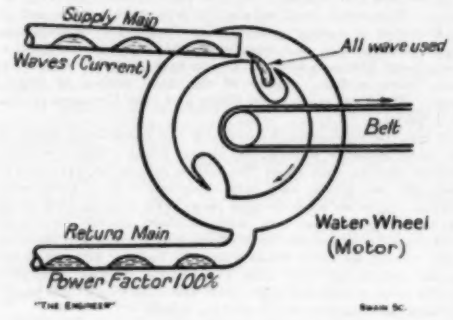


FIG. 18—UNITY POWER FACTOR ANALOGY

then be done during every moment that the pressure is being exerted. The cyclist represents the generator which supplies alternating current, whilst the cycle represents the current-consuming apparatus. The pressure exerted on the pedals represents the electrical pressure or voltage. One complete revolution of the pedals represents one wave or alternation of current or power, technically known as a cycle or period. One wave of pressure is made up of two impulses, one with the right leg and one with the left, and useful work is being done during each half period

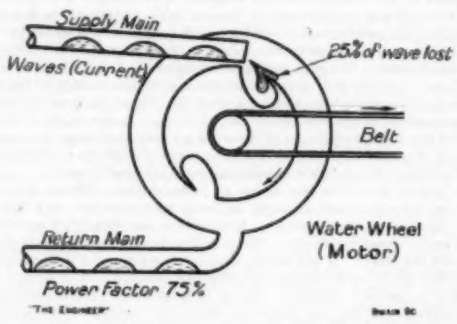


FIG. 19—75 PER CENT. POWER FACTOR ANALOGY

by each leg alternately, and it varies from nothing at the top position, which may be called the beginning of the period, to a maximum after a quarter of a period—that is, when the pedal is half-way down—and to nothing again after a half period, or when the pedal is at the bottom. The same conditions occur during the next half period as the other pedal goes on its downward stroke. Thus there is one instant of no work between the two impulses, when one pedal is at the top and the other is at the bottom. The whole of the pressure is doing useful work during each

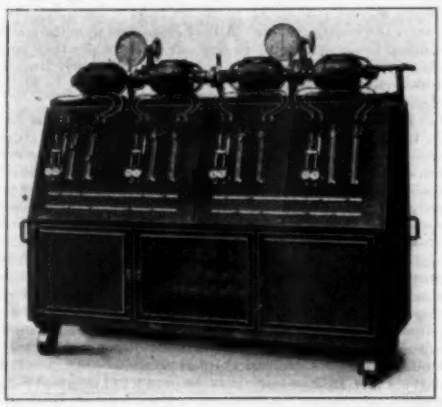


FIG. 20—DIRECT CURRENT MACHINE DESK

half period it is applied, and that represents unity power factor.

Suppose, however, that the cyclist only begins to press on the pedal some distance after it has passed its top position, and maintains that pressure for an equal distance after passing the lowest position—that is, on a portion of the upward stroke. On account of the momentum of the cycle the pedals will now exert a back pressure and force each leg up in turn against the downward pressure which is being exerted. In other words, the bicycle will now be doing work and giving back some of the energy previously imparted to it, the net result being a lower travelling speed, although the cyclist is expending just as much energy. Between the two impulses of work, which will now be of shorter duration, there will be an interval of negative work, which means that the bicycle itself is giving back power to the cyclist, who, of course, is unable to use it to any advantage, as it is merely expended in raising the foot which he is still trying to press down. This is equivalent to the electrical condition of a power factor below unity, for although the apparent work done is the same—the cyclist is exerting the same pressure through each half period—the actual useful work is less, as indicated in the mechanical case by the reduced speed.

When connected to an alternating-current supply nearly all electrical apparatus will generate a back pressure or voltage, and the net result is that the apparent power is greater than the actual power, and between the two half-period impulses of power there is an interval during which the apparatus is actually giving up power, as in the case of the bicycle. This power is useless, and in fact harmful. Just as the cyclist has to exert himself more to maintain the same speed, so do the power station and cables have to carry a heavier current when supplying current to low power factor apparatus than when doing the same work at unity power factor. This so-called excess or

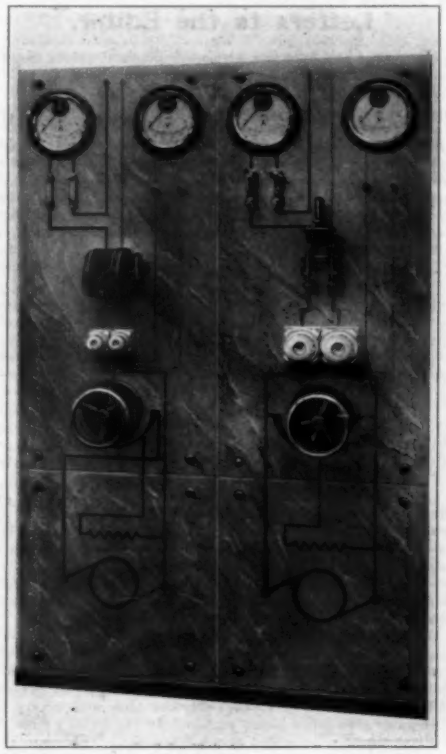


FIG. 22—D.C. DEMONSTRATION SWITCHBOARD

wattless current loads up the generators and cables until ultimately extra generating plant or cables have to be put down. If, on the other hand, the power factor of the consumer's apparatus is good, the wattless current is small and additional customers can be connected to the system without increasing the capacity of the plant and mains. As we have said before, these and other power factor analogies are given in the Electrical Apparatus Company's power factor booklet for the benefit of consumers of alternating current, and not necessarily for the benefit of students of electrical engineering.

While the apparatus described below has not been designed for the purpose of teaching electrical engineering by means of analogies, it has very decided educational value. It is used in the A.E.G. works school at Reinickendorf and in the technical school at Buenos Aires, and was designed by Dr.-Ing. Kurt Labowsky whilst acting in the capacity of a voluntary lecturer in the former school during 1920. Movable demonstration desks, as shown in Fig. 20, demonstrate the performance of direct and three-phase current machines running individually and in parallel, in combination with regulating sets and in cascade connection under all conditions between no load and full load. The direct-current machine desk shown in

FIG. 21—A PORTION OF THE A.E.G. WORKS SCHOOL

Fig. 20 contains four direct-current motors, each rated at about ¾ kilowatt when running at a speed of 1800 revolutions per minute. There are two shunt-wound motors with two series motors between them, and any two of these machines can be directly or indirectly connected together by means of flexible couplings which are easily manipulated by hand levers without moving the motors on the iron underframe.

The A.E.G three-phase current demonstration desk contains four 1¼-kilowatt machines designed for a speed of 1500 revolutions per minute. On the left there is an induction motor, in the centre two synchronous motors, and on the right a synchronous converter. The desks are 1·8 m. high, 0·8 m. wide, and 2·2 m. long. A folding bracket situated behind the motors supports the speed indicators, which are coupled to the motors by a belt, and the necessary instruments, including a voltmeter, ammeter, and wattmeter. In order that the desks may easily be transferred from place to place they are mounted on rubber rollers. Each of the motors has its starter, regulators, switches, and fuses mounted on the desk

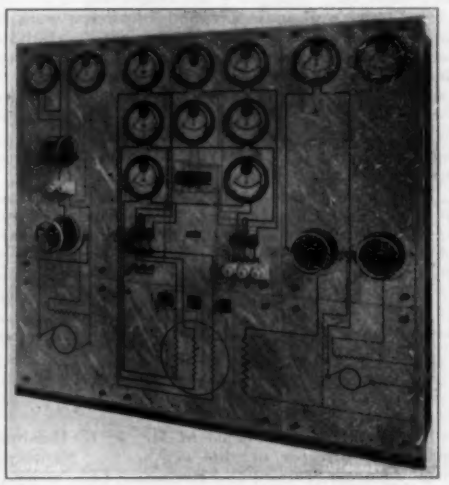


FIG. 23—DEMONSTRATION SWITCHBOARD

panel, which consists of a steeply-inclined polished Geax plate. The apparatus may be connected up directly to the bus-bars or through additional apparatus by means of coloured wires with cable sockets. For the purpose of loading the machines a battery of lamps is placed in the centre cupboard of the desk and is protected by an expanded metal panel. Accessories and tools can be kept in the two cupboards on either side of the compartment which contains the lamps. The motors, switchgear and lamps are arranged so that every operation can be performed.

The following are some of the experiments that can be carried out:—(*a*) On the direct-current machine desk, shunt series and compound-wound generator and motor performance can be demonstrated. Starting, braking regulation and all occurrences arising as the result of operating disturbances and incorrect connections, &c., can be shown and all characteristic curves can be obtained. By means of appropriate couplings main power transmission and the parallel running of motors and generators can be demonstrated and the operation of three-wire equaliser sets

and Ward Leonard sets can be shown. Hunting and other effects can also be produced. (*b*) On the three-phase desk all the normal characteristic performances as obtained on the direct-current desk can be revealed. Furthermore, it is possible to demonstrate synchronising, the effect of cascade connections, frequency changing, methods of starting synchronous and induction motors, phase advancing, methods of regulating voltage and of starting up synchronous converters, &c.

The motors can be directly connected to an existing source of direct or three-phase current, but, as generally speaking, only one of these two kinds of current is available, a small converter is often placed outside the lecture theatre and is regulated inside the theatre by means of a suitable switchboard. This converter usually has a capacity of about 5 kilowatts, according to requirements, and it is wired so that it can supply all the current necessary for electrical instruction and for any cinema or projection apparatus. The converter consists of a driving motor designed to run on the existing supply and a generator which produces direct and three-phase current simultaneously. A wide range of frequency and voltage can be produced by regulating the speed of the motor, or voltage variation may be secured by regulating the field of the direct-current generator. The main supply and also the direct and three-phase current of the motor generator are led to heavy terminals on the demonstration table, on which all the instruments necessary for the lecture are placed that cannot be accommodated on the motor desks.

The illustration Fig. 21 shows part of the A.E.G. works school, whilst Figs. 22 and 23 show two demonstration switchboards built by the A.E.G. Company for an industrial school in Buenos Aires. All the connections of these switchboards, it will be noted, are painted on the switchboard panels, so that they can easily be followed and understood by the students.

Obituary.

CHRISTOPHER WILLIAM JAMES.

We greatly regret to have to record the death of Mr. Christopher W. James, which took place at Hythe, Kent, on Friday, the 13th inst.

Mr. James was the son of the late Mr. Christopher James, consulting engineer of Bristol, and came of a family well known in South Wales and closely identified with the early development of the iron and steel industry in that district. He was educated at Bristol and in Germany, and after an apprenticeship at Chesterfield, he entered the services of Joshua Buckton and Co., Ltd., of Leeds, with whom he spent his working life, becoming managing director and eventually chairman of the company, from which his complete retirement only took place last December.

Mr. James's most important professional work lay in the design of heavy gun and marine engine building tools for the British Government and the armament firms, and in the development, in conjunction with the late Mr. Hartley Wicksteed, of testing machines for engineering materials. He took a leading part in the great advance in the strength, speed and accuracy of machine tools which followed the introduction of high-speed steel.

Mr. James became a member of the Institution of Mechanical Engineers in 1895, and was for some years a member of Council. His war services were of high importance, for he took a leading part in the organisation and management of the National Ordnance Factories in Leeds, the conspicuous success of which was due in no small part to his efforts, and was for some six months in 1917 Director of Ammunition Production at the Admiralty.

JAMES EDWARD HARDMAN.

The death is announced of Mr. J. E. Hardman, managing director of the well-known Manchester firm of Garner, Telford and Hardman, Ltd., as having occurred on the 11th inst. at his home in Pendleton.

Mr. Hardman was born in Heywood, Lancs., in 1858, and until 1893 was in the employment of Thos. Hill and Sons, of that town. He severed his connection with this firm to become associated with William Brierley and Sons, Rochdale, but after about three years he was appointed works manager to Edwin Danks and Co., Oldbury, near Birmingham. In 1899 he was made a partner by Messrs. Garner and Telford, and the title of the firm became Garner, Telford and Hardman, Ltd., and he remained the managing director until his death.

Mr. Hardman leaves two sons, who are interested in the company. He was a member of the Manchester Association of Engineers, and was a founder member of the Engineers' Club.

SIXTY YEARS AGO.

It is somewhat surprising to learn that sixty years ago steam road rollers were unknown in this country. When a road was repaired the fresh metal was left to be crushed down by the traffic, a practice which frequently resulted in damage to the vehicles and the horses attached to them. If we may judge from an account in our issue of August 17th, 1866, of the repairs recently effected on a roadway through St. James's Park, London, the practice followed was to compel the public traffic by poles and trestles and a staff of workmen to pass over the newly surfaced road until it had been crushed smooth. France was ahead of us, for in the issue referred to we read that the streets of Paris were being repaired with the aid of steam machinery. The steam rollers employed were the patented invention of E. Gellerat and Co., of Paris, and by a contract which that firm had entered into with the Prefect of the Seine seven of the machines were to be kept at the disposal of the municipality for a period of six years, at an annual remuneration of £4000 as a minimum. A general picture of life in London at that time, as affected by the management of its municipal affairs, was given in the same issue in the course of a leading article reviewing the proceedings and enactments of Parliament in the session which had just closed. Local government was still in the hands of the "vestries." Our pavements, it was said, were uneven, and our macadam imperfect. Our gas was dim and our water yellow and loathsome. London, a speaker in Parliament had stated, was the most uncomfortable capital in all Europe, and although sanitary matters were frequently in the forefront of public discussion, the vestries refused to spend money on works necessary for the preservation of public health. It was not to be wondered at that in these circumstances cholera had broken out like a scourge, and was carrying off thousands of the inhabitants. The Russell-Gladstone Government had just been defeated on the Reform Bill, but we expected little improvement in the attention paid to internal affairs from the Tory Government which had come into office. Seventy million pounds had been expended during the preceding seven years on the Navy, but in spite of the fact that the Navy possessed 400 to 500 ships, the naval reserve was so small that the utmost difficulty was found in relieving vessels on foreign stations. Our harbours were encumbered with scores of useless hulls, on the maintenance of which millions were being annually expended. Tragic disasters to the steamers London and Amalia had pointed to the urgent necessity of legislative action to secure the safety of passenger vessels, but apparently all that was to be done was to revise the qualifications expected of Board of Trade surveyors. Reservoir disasters, mishaps and outrages on trains, accidents to railway bridges and other menaces to public safety had illustrated farther legislative necessities, but Parliament had declined to interfere or had indefinitely postponed consideration of its responsibilities in these matters. The country was suffering increasing loss from strikes in its staple industries, but Lord St. Leonards' estimable Bill for the establishment of Councils of Conciliation had again failed to pass. Even the education of the people had been neglected; the only attempt made to improve matters in this direction was a proposal to exempt public libraries and museums from rates, and even this small measure had suffered an adverse vote.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

NEW FILTRATION AND PUMPING PLANT AT WALTON.

Sir,—Your series of articles on the above subject is very timely, in view of the importance of the public being kept informed of the activities of the Metropolitan Water Board. The writer has given very close study for a period of thirty-four years to the water supply of London, and during the last thirty years he has made many visits to most of the important works of the Board.

The leading article in your current issue speaks of "the Board's policy with regard to reservoir construction." It must be remembered that owing to the strictly limited powers of abstraction, the Board is now pretty much in the position of a water authority abstracting water from an upland stream, only in place of sending down compensation water, it pays an annual sum to the Thames Conservancy, &c. Many people have heard so often that a month's storage is desirable for the purification of river waters that they imagine that the Metropolitan Water Board constructs reservoirs solely for purification purposes. That is, of course, not so. No authority would dream of providing a month's storage for "quality" reasons. A few days is the limit of economical storage.

The most remarkable feature about the adoption of pre-filters by the Metropolitan Water Board is that although a pre-filtration plant—Puech Chabel type—was put down by the East London Water Company about thirty years ago, the Metropolitan Water Board has adopted pre-filtration only very recently. In 1901 the writer wrote to the late Mr. W. B. Bryan, M. Inst. C.E., regarding the East London plant, and was informed that it was operating quite satisfactorily.

During the last quarter of a century pre-filtration—without coagulation—has been adopted in many plants all over the world. Probably the largest plant is the Torresdale plant at Philadelphia, dealing with about 200 million gallons per day. This plant is over twenty years old, and deals with a very bad river water after a few hours' storage. In the writer's view, one of the greatest advantages of pre-filtration in this country is that it takes away the terrors of long periods of hard frost. When the effects of the great frost of 1875 on the London filters are remembered, the great advantage of a large extension of the "period" of slow sand filters is apparent. The filters can all be cleaned at the end of the autumn and no more cleaning will be required till the winter has passed. A filter plant which gives excellent results at all other times becomes during severe frost an inefficient apparatus. In very cold weather the efficiency of open filter beds is greatly reduced, and long severe frosts makes it impossible to clean the filters. In a short time the output of the filters is very much reduced, and improperly treated water has to be used to make up the deficiency, or emergency chlorination has to be employed.

The oldest British pre-filtration plant of the Walton type is that of the York Water Company, which has been in use for some twenty years. A difficult water is dealt with as follows, viz.:—Storage for less than two days; rapid filtration—rate about 60 × standard; slow sand filtration—rate 0·8 × standard. It will be noted that the final filtration is conducted at quite a low rate, which is very unusual. A very fine water is turned out. Another water company which recently put down a plant similar to that at Walton finds that the cost of filtration is only about one-third of what it was previously. A short distance up the river from Walton we find a water company employing open pre-filters of a very simple type. The raw Thames water is first passed through two gravel pre-filters, then through a rough sand pre-filter, and finally through ordinary slow sand filters. This produces a very fine water, always free from *B. coli* in 100 cc., but as an additional precaution a very small dose of chlorine is administered.

With regard to the Walton pumping plant, there is one point that deserves attention, viz., the fact that both engines and pumps are entirely exposed. In too many plants the pumps are hidden beneath the floor, which is a very inefficient practice. You can see the engines, but you cannot see what they are doing. This takes away all dignity from the engines, and all for the sake of having a fancy-tiled floor. The Metropolitan Water Board is now in a very favourable position in respect of storage and filtration works. The storage available is equal to about three months' supply of the daily output of filtered water. There are some rapid filters and over 170 acres of slow sand filters.

It may be interesting to compare the purification works of the three greatest waterworks of the world. First, we have Chicago, dealing with about 700 million gallons per day, with no reservoirs, no filters, and only chlorination as a purification process. Next we have Greater New York, dealing with about 630 million gallons per day, with no filters, except for a small local source, purification being effected by storage and chlorination. Lastly, we have Greater London, dealing with about 270 million gallons per day, with about three months' storage of river-derived water, slow sand filters and some rapid filter plants, and also chlorination for a part of the supply.

August 16th. M. Inst. C.E.

MAN AND MACHINES.

Sir,—In your issue of July 16th you published a leading article on man and the machine, reviewing a book by an American writer entitled "Ouroboros." It is all to the good that engineers in the constant stress and strain of present-day technical activity should have their attention diverted at times to problems in the philosophical or moral sphere which their activities tend to create. You will be told no doubt, by many of your readers, that philosophy and morality are outside the scope of a technical journal. In the abstract, that may be conceded, but if the profession of the engineer is "the direction of the forces of nature to the use and service of mankind," a moral obligation is at least implied. To do nothing, if we feel that the industrial trend is not making for real progress, to acquiesce in a system which aims at production for its own sake, to help by technical skill in the production of wealth which people on the whole have not been trained rightly to apply and enjoy, is surely not within our charter. We may feel quite helpless at times if we think about it at all and console ourselves with the thought that if we do our job well and make a profit for our employers we need not worry about the problematic results of our work which, like the distant ripple, is unobserved by him who drops the stone into the water. Well, if we concentrate only on the "standard of living," the standard of thinking must inevitably suffer.

Let us return to the theme of "Ouroboros. There, at any rate, may be found an array of facts, whatever one may think of the author's conclusions. In the craze, one can call it nothing else, for mass production, the machine has become the master, man the slave. If the machine pays its slave good wages, he is still a slave, with all his individuality crushed out of him. Is this progress? Frankly, one is a little tired of the constant insistence of the lay press on American methods. Even one so usually acute as the editor of the *Observer* heads one of his Sunday articles "Ford or Lenin." One naturally asks, why either? Is there no sane balance between extremes of madness? Between one individual destroying millions of capital and another accumulating them?

If one is to institute a comparison one is tempted to say that out of the desolation caused by the Bolsheviks, Russia may yet find her soul, but that in the vast accumulation of material wealth, America is in danger of losing hers. "Ouroboros" is at any rate the sign of an awakening, and the American manufacturer will no doubt work out his own salvation, but what of ourselves? Are we slavishly to copy a system which is already showing signs of cracking, or are we to develop on our own lines, based on the craftsmanship and individuality which have been handed down to us from past generations, when quality, and that indefinable something which one might almost call artistic merit, were the criterion rather than quantity. There has been no doubt a great temptation to depart from these standards in the years succeeding the war. All our customers were the poorer, and many could not afford to buy our wares while they could obtain something similar at a lower price. But their situation will gradually remedy itself and we shall once again be able to hold our own.

Let me point a moral and adorn a tale. I note in the daily press that the American manufacturers of cars had been greatly exercised by the possibility of the home market becoming saturated, and as the result of an inquiry, they had come to the conclusion that two million cars will be scrapped this year, and that shortly the annual scrapping will be three millions. I pass over the wasted energy of the boasted mass production which scraps its products every few years, and give as a contrast an experience of my own. I use daily a car of English make which left the factory in 1913. It has, of course, been properly cared for, but it has never let me down on the road and is running as well to-day, if not better, than on the day it left the works. I dare say that there are cars of other English makes of which a similar tale could be told. One can feel an affection for such a car, for behind its mere mechanism there is the individuality of the craftsmen who produced it. It is the product of men and not of machines. H. C. A.

August 16th.

ELECTRICITY SUPPLY.

Sir,—In your leader on the above subject in your issue of August 13th, you draw attention to the cost of distributing current from super-power stations. I do not profess for one moment to understand the subject under discussion, but I do know that the dearest current in London is supplied from a super-power station, and that when a protest is made to the company concerned, we are always informed that the high price is due to the amount of capital sunk in the earth. In other words, in transmission.

August 16th. Layman.

Railway Matters.

It is officially announced that the London and Home Counties Traffic Advisory Committee of the London Traffic Branch of the Ministry of Transport will open its inquiry into the traffic conditions in South-East London in October.

An electrically-operated train, bound for Munich, was derailed when entering Langenbach Station in Upper Bavaria on Friday morning last. Twelve passengers were killed. It is stated that the line was under repair at the time.

The directors of the Great Western Railway have appointed Mr. J. C. Blundell, the divisional engineer at Shrewsbury, to succeed, as divisional engineer at Cardiff, Mr. H. Reid, who was taken ill and died suddenly on June 24th. Mr. A. A. Davis, chief assistant to Mr. Blundell, succeeds him.

Four coaches of a passenger train from Shepperton were derailed as it was entering Waterloo Station on Friday evening last. The road was badly damaged, but there were no personal injuries, and the incident would not have attracted the attention it did but for the fact that the accident occurred about 6.30, and seriously interfered with the outbound suburban traffic.

The Bureau of Labour Statistics of the United States Department of Labour said in a recent issue of its *Monthly Labour Review* that "whatever may be true of other industries, American railways have maintained a successful fight against conditions which tend toward increased accident rates." A table shows that in 1916, for every 1000 hours' exposure to risk there were 1·38 fatalities among trainmen; by 1920 the figure was 1·20; and in 1921 it was 0·72. In 1924 it was 0·65.

In this column on April 30th we mentioned that under a Ministry of Transport Order an extension of time had been given to the owners of privately owned wagons, possessing less than 20,000, to have them equipped with either-side brakes by November 7th, 1931. That has suggested to a Member of Parliament that there has been some preference shown to those owning over 20,000 wagons, and he recently asked the Minister of Transport whether he would take steps to secure that equal treatment be extended to all classes of traders. The answer, of course, was that, as related in our paragraph, the owners of over 20,000 wagons already had up to 1931 to do their work, and now all have the same time.

As was anticipated in a note on our Journal page last week, evidence was given at the inquiry into the Manors Station, Newcastle, collision, conducted by Major Hall, of the Ministry of Transport, that the button in the controller handle of the electric train was tied down. The motorman thus was able to leave the controller handle in its running position. As the question has been asked why, on that section, there was not, as on the Underground, the complementary safeguard of the automatic stop, we would remark that in no case in this country is an automatic stop provided on electrically-operated lines in the open, as motormen there have, in contrast to the Underground railways, a long distance view of the signals.

As related in this column in our issue of April 28th, 1922, the Solway Junction Railway between Annan and the Maryport and Carlisle section is closed against passenger traffic owing to the condition of the Solway Viaduct. The Wigton Urban District Council has urged that the necessary repairs should be made to the bridge so that the line can be opened, as, at present, a journey through Carlisle is necessary which involves a further 23 miles' ride. The line actually began with a junction with the Caledonian at Kirtlebridge, and was opened for goods traffic on September 13th, 1869. In Bradshaw's Railway Manual for 1871 it was said, "This line crosses some two miles of peat moss at Bowness, the moss in places being over 50ft. deep." The line here had to be laid on faggots, ballasted with ashes and strengthened with 18ft. sleepers. The road, though perfectly safe, was somewhat elastic and the company was obliged to run heavy mineral trains over it for eleven months—which it did without an accident—before the Board of Trade would pass it for passengers. The viaduct over the Solway is the longest iron pile bridge in Great Britain, probably in the world. James Brunlees was the engineer. In January, 1881, the bridge was wrecked by ice and was closed for reconstruction until May, 1884. The renewal was under consideration when the war broke out, but it was fortunate that the work was not undertaken or the bridge would not have been available for the heavy iron ore traffic it carried. When, later, the matter of renewal was considered, it was found that the price of labour and material had risen so much that the expense would not be justified.

Contrary to the experience with the wages boards in this country, established by the Railways Act, 1921, those set up in the United States by the Transportation Act, 1920, have already been abandoned in favour of a new scheme which was passed in the recent session of Congress. What is remarkable is that the labour brotherhoods have agreed to arbitration. Their experience in that direction was certainly unfortunate for them; so much so that at the time of a serious crisis just before America entered the war they refused to let the question as to whether the companies could afford an eight hours' day go to the arbitration of the Interstate Commerce Commission—a body that could not be charged with being unduly favourable towards the railways. Under the Transportation Act a Railroad Labour Board of nine members—three for the companies, three for the men, and three, appointed by the President for the public—was set up. The members were each to be paid a salary of 10,000 dollars a year and there was to be a secretary at 5000 dollars a year. It is important to note that during his term of office no member was to be actively engaged in any organisation of employees or in the service of a railway company or be a shareholder in a railway company. Now there are to be joint adjustment boards from the companies and men only who may refer undecided questions to arbitration. Failing agreement, the matter is to go before a permanent board of mediation to be appointed by the President, and in case of failure to agree there an emergency commission is to be set up by the President, which shall determine the facts and report upon the rights and wrongs of the dispute.

Notes and Memoranda.

The offices of the newly formed Research Association for the Paint, Colour and Varnish Industry are at 8, St. Martin's-place, London, W.C. 2.

According to some particulars given in the *Bulletin* of the Chinese Government Bureau of Economic Information, at the present rate of exchange goods can be transported by junks on the river Hwaiho at the rate of 0·95d. per ton per 100 miles.

For the purpose of keeping floating *débris* from choking the gratings at the circulating water intakes at an American power station, a pipe has been installed just above water level in front of the grid. The pipe is drilled with ¼in. holes, and is supplied with water at 120 lb. per square inch. The jets of water issuing from these holes wash away any leaves, sticks and snow that might clog the grating.

The Manitoba Government's hydro-electric transmission system is to be extended another 100 miles at an estimated cost of 250,000 dollars. The extensions will take in fifteen towns in Southern Manitoba that are now without power service. The towns and villages directly affected are Haywood, St. Claude, Rathwell, Treherne, Holland, Cypress River, Glenboro, Notre Dame de Lourdes, Cardinal, Altamont, Somerset, Swan Lake, Manitou, Darlingford, and Kaleida.

The erection of a new plant in Montreal devoted to purifying carbonic acid gas under the Backhaus process is announced by Mr. J. R. Colby, vice-president of Canadian Carbonate, Ltd. It is anticipated that this plant is a forerunner of several which will be installed throughout Canada for the use of the Backhaus process. Canadian Carbonate, Ltd., is the largest producer of carbonic acid gas in the British Empire, and has at the present time in operation, plants at Halifax, Montreal, Toronto, Hamilton, Winnipeg, and Vancouver.

The British Engineers' Association, Inc., reports that a number of orders and repeat orders have been placed abroad for grab dredging and excavating equipment, among them being one for a large grab dredging unit for the harbour of Beira, East Africa. Others in hand are for Belgium, Holland, Australia, South America, China and Japan. These, with other contracts secured in England and Ireland, make a striking list, which, it is thought, foreshadows a further recovery in the branch of civil engineering devoted to docks and harbours development.

In the process of raising the United States submarine S 51, attempts were made to tunnel through the clay beneath her by means of water jets, 2½in. in diameter at a pressure of 50 lb. per square inch, but the divers were impotent to hold them against the reaction. One of the mechanics, however, made a nozzle which overcame the trouble. This nozzle had a normal orifice and five other smaller ones directed backwards. The reaction of these jets counterbalanced that of the main jet, and the diver could comfortably control the nozzle when working at even 200 lb. pressure.

According to the *Chemical Trade Journal*, the wax extracted from the tissues of the flax plant, which may amount to 10 per cent. of the total, is of a dark green or brown colour, according to the state of the chlorophyll present, which is probably determined by the process of retting. It resembles bees-wax closely in character, but is slightly harder and rather more brittle, and is capable of an extremely high polish. The polished film produced by flax wax is more durable than that of carnauba, on account of its greater plasticity. Flax wax would be, therefore, on account of these properties, a very valuable constituent of polishing preparations.

The keel of the first large electric passenger ship was laid at Newport News, Virginia, March 20th, at the works of the Newport News Shipbuilding and Dry Dock Company. The vessel, the largest commercial craft built in the United States, will be the first of three sister ships, costing approximately 21,000,000 dollars, and she will enter the New York-California passenger trade in 1927. The new liner will be 601ft. 3in. long, 80ft. beam, and will have a speed of 17 knots. Oil-fired boilers will furnish steam for two 9000 horse-power General Electric turbine generators, which in turn will provide the electricity for driving the motors connected to the two propellers. The electrical equipment is now being manufactured at the Schenectady plant of the General Electric Company of America.

An exceptionally large hydro-electric plant is being built for the Philadelphia Electric Power Company on the Susquehanna River, within four miles of tidewater in the State of Maryland, U.S.A. A dam 4800ft. long—300ft. longer than the Muscle Shoals Dam—is being built across the river to form a reservoir of 8100 acres. The impounded water will operate waterwheel-driven electric generators of large size, and the energy will be sent over high voltage transmission lines into Philadelphia, 75 miles away. Ultimately this hydro-electric station will contain eleven generators, each rated at 50,000 horse-power, or 36,000-kilowatts. The initial installation will include seven of these units, giving the station 350,000 horse-power. The Niagara Falls Power Company development produces 452,500 horse-power, and Muscle Shoals 260,000 horse-power.

What is believed to constitute a high record for pig iron output is the achievement of Central A furnace of the American Steel and Wire Company, at Cleveland, Ohio, United States of America, when on July 22nd it made 1003 gross tons of basic pig iron. The furnace has, according to the *Iron and Coal Trades' Review*, a 650-ton daily capacity rating, and was rebuilt in 1924 from a 500-ton furnace. It has a height of 95ft., and a hearth 20ft. in diameter. Despite eighteen hours of lost time during July, the average daily rate of the furnace up to and including July 23rd, was 781 tons. No scrap was used in the burden except runner scrap, which constituted about 2 per cent. In March, 1923, the blast-furnace of the Trumbull-Cliffs Furnace Company at Warren, Ohio, established a high mark of 1011 tons of basic pig iron in a single day, and for the full month averaged 753·6 tons per day. The scrap charged into this furnace, however, amounted to about 18 per cent.

Miscellanea.

It is expected that the plant of the South African Tungsten Mines, Cape Province, will be at work by the end of next year.

During one day in June last the newsprint mill of the Abitibi Company, at Iroquois Falls, Ontario, produced 552·5 tons of paper.

Some deposits of potash of exceptional purity are said to have been discovered by boring near Solikamsk, in the Ural Mountains.

During June the Transvaal platinum reduction plant milled 817 tons of ore, which is estimated to contain 104 oz. of the precious metal.

Several Norwegian whale fishers have been attending trials at the Bofors Works of a new breech-loading gun for whale fishing, which has been constructed at those works. It is announced from Stockholm that the trials were successful.

The river Kharatoa, which flows through the districts of Bogra and Rungpore in East Bengal, is rapidly silting up and the Bengal Government is considering a proposal for its re-excavation. It is proposed to divert waters from the river Bangali, through the Kata Khal, which connects the Kharatoa with the Bengali, and to re-excavate the river in some parts, so that the flow may not be impeded.

The programme of the New Zealand Sounds Nitrates Syndicate provides for the initial development of 50,000 horse-power in Deep Cove from the existing water power there, and for the discharge of Lake Manapouri into Smith Sound to develop a further 250,000 horse-power, making the total output of the scheme some 300,000 horse-power, which will be by far the largest hydro-electric development south of the Equator.

A serious landslide occurred on the face of the bluff on the Tennessee side of the Mississippi River at Memphis, on July 25th. A section of land at the foot of Butler-street, estimated to be 1000ft. long and nearly 250ft. deep, broke away and slowly settled down into the river valley until the original surface was about 50ft. below its former position. The slide carried with it the whole plant of the West Kentucky Coal Company, except an office building which stood at the south end of the property.

According to the annual report of the Commercial Secretary to H.M. Embassy at Brussels, preliminary arrangements for a universal exhibition to be held in Belgium in 1930 are well advanced. As at present decided that there are to be two sections. The main section will be at Brussels, whilst the colonial and marine section will be at Antwerp. There is a further proposal for a section at Liége, but on that point no decision has at present been reached. Both at Brussels and Antwerp powerful committees have been formed and the necessary capital funds subscribed.

According to the *Engineering News-Record* of August 5th, a cave-in which occurred 12,000ft. in from the west portal of Moffat Tunnel on July 30th, resulted in the death of one man and the probable death of five others. The men were working in the enlargement of the railway tunnel. They were just building a "jumbo" and had the rock all braced up, when one big piece broke loose and fell on the "jumbo" set and broke the braces which were holding the rock. The destruction of the "jumbo" brought down about three or four hundred tons of hard slabby rock, which caught the men underneath the mass of broken timber.

Six months is the time limit fixed by the Spanish Government for the resumption of negotiations between Spain and Portugal and two years for the completion of an agreement for the harnessing of the Douro Falls in the part of the river forming the boundary between the two countries and the rendering navigable of the Douro from somewhere near Zamora to the sea. In spite of the necessity of awaiting an agreement with Portugal, concessions are to be given without delay to the Sociedad Hispano-Portuguesa de Transportes Eléctricos and other interests for the production of electrical power on various rivers, including part of the Douro. Even if no agreement is reached with Portugal and only a reduced scheme is carried out, the increase in the amount of electrical power available in Spain will affect the consumption of both Spanish and foreign coal.

The Swedish newspaper *Stockholms Tidningen* says that the plan for producing a Swedish standard type of cheap passenger motor cars, to compete with cars now being imported into Sweden, and also, perhaps, capable of being sold to neighbouring countries, has now been carried into effect. Ten cars were completed some little time ago, and trial runs were immediately made from Stockholm to Gothenburg and Norrland, which gave very satisfactory results. The manufacture of these cars on a large scale will not begin, however, until thorough trials have been concluded. The new car is described as being a four-seater, with nice outlines and a very solid appearance. The engine has four cylinders, all in one piece, suspended on three points. The cylinder volume somewhat exceeds 2 litres, and engine power developed is said to be well over 20 horse-power. The whole car is of Swedish make except in certain details, the electric fittings, for example, being on the Bosch system and the gas apparatus being of Solex construction.

It was recently announced at Liverpool, by Sir Archibald Salvidge, that the Government had consented to the scheme for the construction of a new road from Liverpool to East Lancashire going forward. The work can be put in hand in the autumn, and so afford employment for many men during not only the coming winter, but for the next four or five years, the period which it is estimated must elapse before the road is finally completed and open for public use. The total cost is estimated at approximately £3,000,000, towards which the Ministry of Transport will give three-quarters. The balance will be provided by contributions from the Liverpool Corporation, the Lancashire County Council, local authorities on the route of the new road, and Mersey Docks and Harbour Board. The total length of the road will be 26¼ miles, involving the construction of about twenty new bridges. Sufficient land will be acquired to leave 100ft. between the fences, and the carriage way between kerbs will be 40ft.

SOUTHAMPTON DOCKS—ELECTRICAL EQUIPMENT

MR. HARRY WAUCHOPE, SOUTHAMPTON, ENGINEER

(*For description see page* 188)

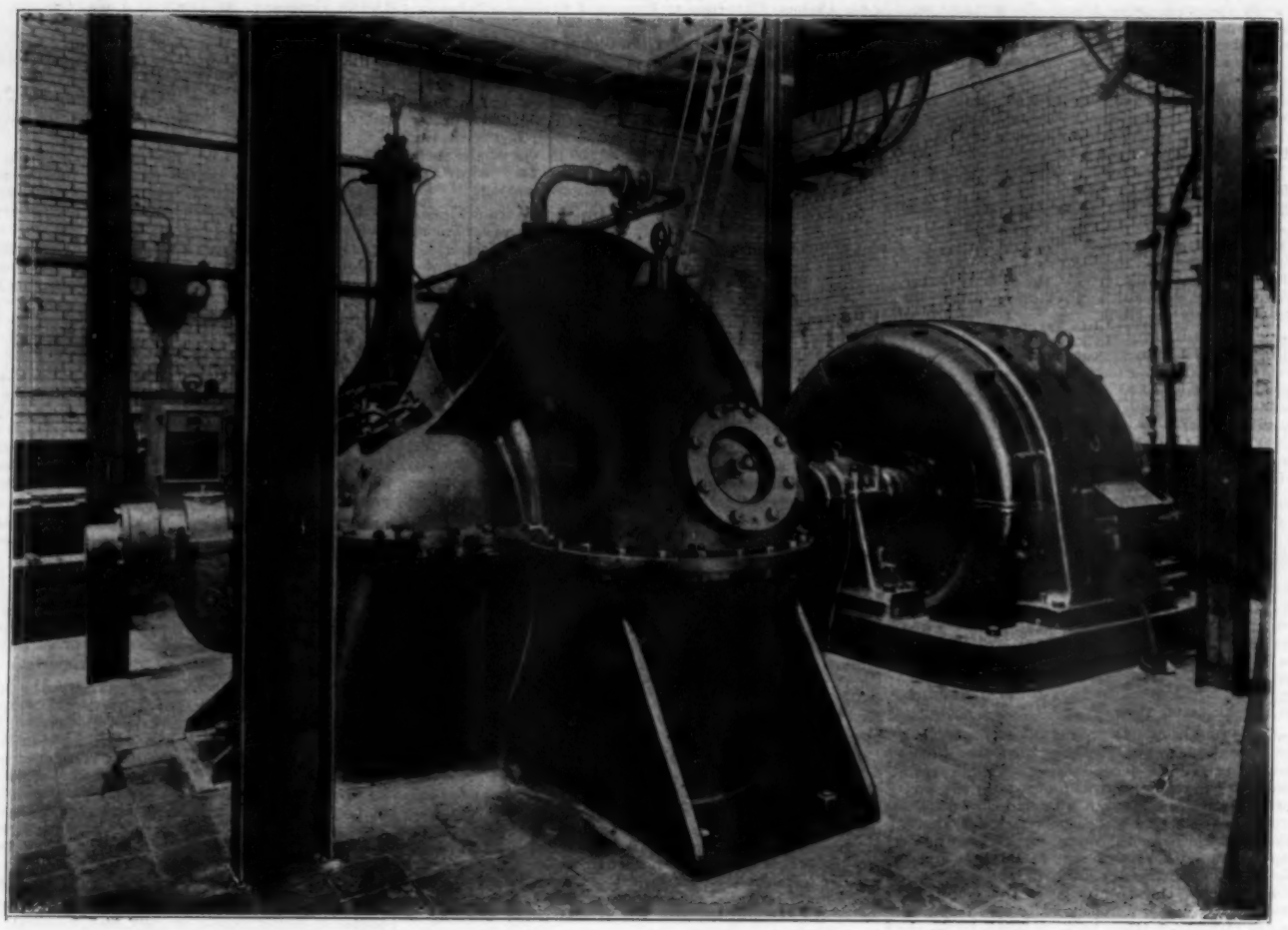


FIG. 7—1200 H.P. ASYNCHRONOUS-SYNCHRONOUS MOTOR DRIVING DE-WATERING PUMP IN NO. 6 PUMPING STATION

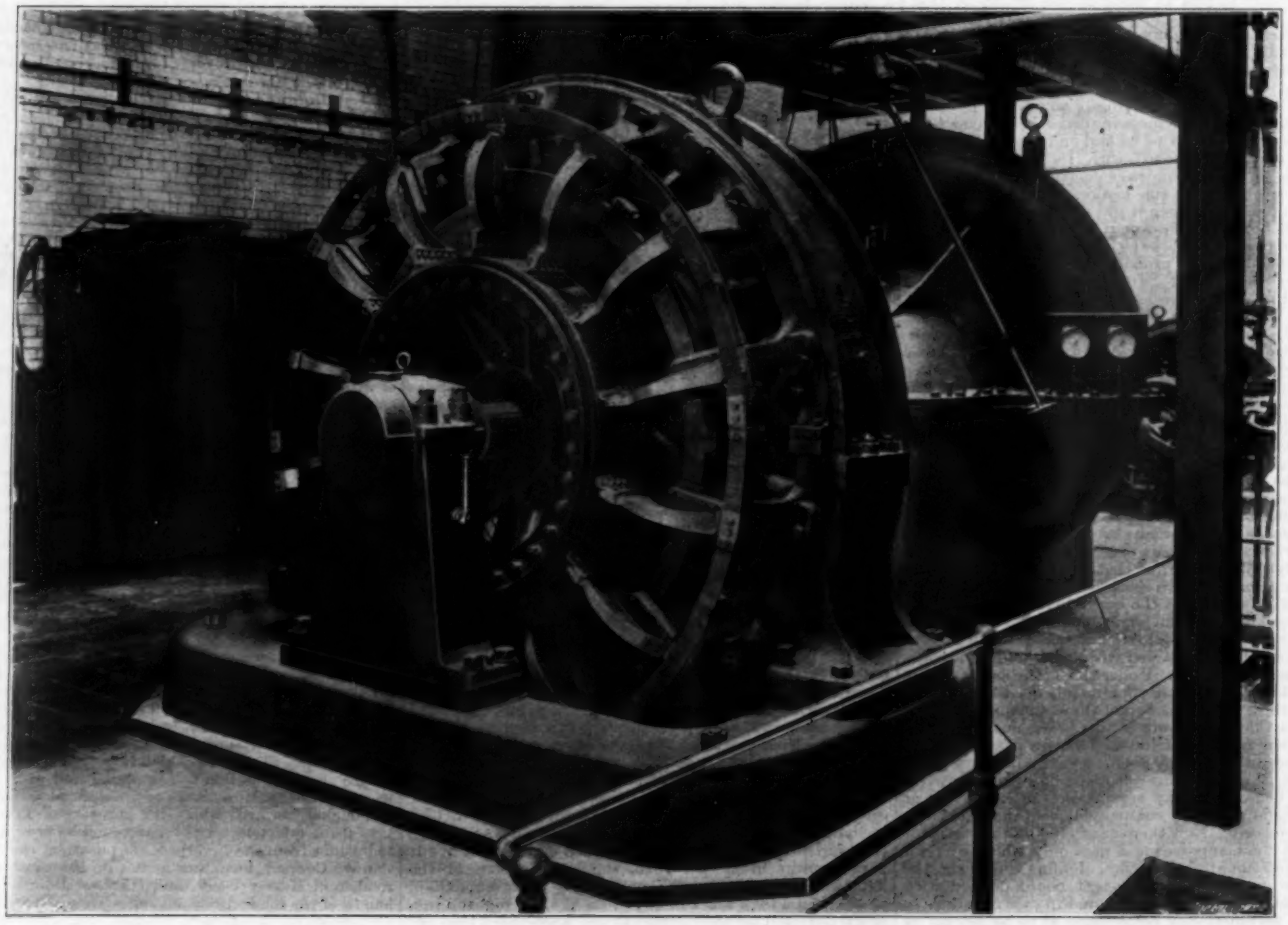


FIG. 8—1200 H.P. DIRECT CURRENT MOTOR DRIVING DE-WATERING PUMP IN NO. 6 PUMPING STATION

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THE ENGINEER.

AUGUST 20, 1926.

Production Costs and Trade.

The idea that a general industrial activity is only possible with a financial stabilisation is obviously correct as a general principle, but it does not mean that all nations will benefit from a revival to the same extent, and there is, unfortunately, ground for supposing that some producing countries will, for the time being, suffer far more than certain former consumers. At present British manufacturers are inclined to believe that, when finances are straightened out on the Continent, there will be a revival of trade in which they will largely participate. If the conditions were normal there is no doubt that that belief would be fully justified. British producers who are looking forward to an early improvement in the situation should, however, bear in mind that fundamental changes are taking place on the Continent which may profoundly alter trade conditions in the future. That does not mean that British makers will be less able to do business in European markets than formerly. It merely implies that such business is only possible by adapting industrial methods to the new continental conditions, which are based upon the theory that the various countries can only be saved from economic disaster by intensifying and cheapening production. Whatever may be said against a policy which aims at selling abroad and buying nothing in return, it is certain that nearly all European countries are now striving to achieve that result. There are very few foreign markets which can afford to buy indefinitely and sell nothing, and if European producing countries wish to transact business with those markets they must purchase products in return. For the moment an attempt is made to ignore completely this obvious economic principle. In France and Italy there may be some excuse for the efforts of politicians to defy economic laws. The one idea that dominates legislation at present is to intensify production and foster the development of home and colonial resources, particularly in the way of procuring all the raw material that may be required. Solely with the intention of adjusting finance and stabilising currency, those countries have embarked upon a policy of restrictions which is certain to have the effect of reducing importations to a very low point. How long they will be able to continue those restrictions it is difficult to foresee, and it may be supposed that a reaction will set in eventually which will favour a return to normal conditions of trade. Those conditions will, however, be entirely different from those that have governed trade and industry in the past. Each country will have so far developed its own resources that it will require less from abroad, and for years to come a reduced purchasing power will keep the demand below the production.

These two factors of increased output and smaller consumption arise from different causes, and while in France they are due to purely financial considerations, they are, in Italy, both financial and economic, and, in Spain, purely economic in the sense that the sole aim of the new system of prohibition of imports is to provide work for the unemployed. In all these countries it is sought to suppress largely the social laws which at present limit production. In France it is remarkable that one of the men's unions is agitating for a suppression of the eight hours' working day on the ground it is "revolutionary." This impression is due to the considerable part played by the Confédération Générale du Travail in securing a limitation of the hours of labour. The advanced Socialist tendencies of that body have always given a revolutionary character to its propaganda work, and when the eight hours' working day had been secured the secretary of the Confédération declared that the only object of the reform was to secure higher wages for the men. He affirmed that Frenchmen would be ashamed to admit that they were unable to work more than eight hours a day. For a long while past the Confédération has remained quietly in the background. It has lost its influence with many of the affiliated unions of a less extremist character. The only opposition to a suppression of the eight hours' working day comes from those employed in the State services, railwaymen and others who are paid fixed wages. It appears certain therefore that more hours will be worked in France, and it is hoped, in that way, appreciably to reduce production costs and avoid the necessity of importing so much foreign labour, which necessarily means an exportation of capital from the country. The idea is now firmly rooted amongst the French that more working hours mean more trade. While so much is being done to increase production, the import duties are to be raised considerably, and, with so many prohibitions and restrictions, the opportunities for doing business in the French market are, for the time being at any rate, reduced to a minimum. In Italy the organisation in favour of a "national economy" is much farther advanced. Legally, a nine hours' working day is in force, but practically there is no limit to the number of working hours. In the shops, it is only permissible to display Italian goods, and co-operative sales organisations are established everywhere with the idea of bringing down prices. The intention is to encourage home manufactures without the aid of prohibitions, for it is recognised that any attempts to exclude foreign goods will have the effect of raising the prices of home products. Nevertheless, preference must always be given to Italian manufactures when the cost does not exceed that of similar imported goods by more than 5 per cent. Curiously enough, Spain has carried the system of prohibition much farther than her neighbours, solely with the object of developing home industries and providing work for the unemployed. Elsewhere on the Continent there is the same tendency to increase home production, and the balance of supply and demand has been so completely upset, that some international arrangement for a European co-operation in the future appears inevitable.

The situation is complicated by the unexpected and often bewildering effects produced by these efforts to reorganise trade and finance. Living costs lag a long way behind currency fluctuations, and when costs have fairly started on an upward movement it is difficult to stop a steady inflation, even when the franc has undergone an improvement. As a matter of fact, the influences that favour an improvement in the franc tend necessarily to raise prices, and that introduces an element into the situation which will certainly affect some of the European producing countries. During the three months ending July, which marked the period of the collapse of French currency, the average index of living costs rose from 702 to 856, and the average index for raw material advanced from 794 to 990, minerals and metals reaching the figure of 1025. As soon as the franc retreated from its record inflation it was expected that prices all round would decline, but so far from falling many of them hardened. The heavy taxes, increased railway rates and higher charges of all kinds have more than balanced the improved money values. Production costs therefore advance, and that explains, in part, the necessity of augmenting the output, with the same charges, by means of a longer working day. Then, to protect the home manufacturer from foreign competition higher import duties have to be imposed. The result is

a complete dislocation of normal economic conditions and a serious impediment to foreign trade. The situation would appear hopeless if it were not for the fact that nearly all the countries in Europe are necessarily dependent upon each other. There is not one that can become self-supporting. France believes that scientific research and engineering skill will eventually place her beyond the necessity of purchasing foreign raw material and foodstuffs, and will enable her to manufacture all she requires at home; but there is a huge surplus of products which must be exported, and it was merely with a desire to recover an important market that France entered into a temporary commercial arrangement with Germany, pending the carrying out of a permanent treaty. When continental countries clearly see the limitations of their efforts to render themselves independent of foreign supplies they will be compelled to enter into commercial treaties for their common benefit, and those treaties will become inoperative unless they are carried out in a fair spirit of reciprocity. During this period of industrial and commercial adjustment the situation will remain difficult. So far as France is concerned, the tendencies are in the direction of higher production costs, which awaken a fear of probable disaster to industry if the franc should be stabilised at too high a value. There is a vague idea that the situation generally may be saved by a European industrial and commercial union. The impression is growing that the formation of rail, steel and other unions will be followed by a general consolidation of interests. Those interests, however, are so conflicting that the realisation of such a plan appears somewhat remote. It nevertheless favours the creation of separate unions, and it is probable that a solution of the present complicated problems may, at some time, be found in a European organisation. Until then British firms will have to prepare to enter restricted markets by bringing down their own costs to such a level as will enable them to compete with foreign makers, who are, in a general way, assured of the patriotic collaboration of their men in doing what is necessary to increase and cheapen production.

Atmospheric Pressure and Earth Crust Movements.

In early times the god Æolus was believed to exercise his authority over the wind by confining it in, or releasing it from, a vast underground cavern situated, some said, in Stromboli, or, as others would have it, in Lipari. Since wind storms, according to this view, had their origin in the bowels of the earth, it was only natural that, when the miners of long ago encountered fire-damp in their pits, they should regard it as bad weather in the making. Some of them called it "schlagwetter"—that is, literally, "blow weather"—and that it represented Æolus at work preparing a storm was borne out by the repeated observation that fire-damp made its appearance in the mines some considerable time before signs on the surface pointed to the approach of disturbed weather. That an association between the weather and the presence of fire-damp in mine workings should have been established on a wholly mythical basis, and that in later times it should be proved to be a physical fact, is an example, one of many, of the unconscious wisdom of the ancients. With the advance of scientific knowledge, Boyle's law replaced the machinations of the wind god as an explanation of the observed facts. It was argued that when the atmospheric pressure fell, not only had sailors at sea to expect a coming storm, but miners had to anticipate possible danger by the release, under the reduced pressure, of the gas imprisoned in the fissures and seams. Conversely, a rise in the barometer conveyed a promise of fair weather, and stopped the escape of gas in mines by compressing it in the cracks, pores and other outlets. This simply founded belief still survives in spite of the fact that nearly all the big colliery explosions of the past forty or fifty years have occurred while the barometer was high or rising, and not low or falling. The connection between atmospheric pressure and the invasion of mine workings by fire-damp cannot be explained by an elementary application of Boyle's law. The phenomenon, indeed, apparently runs counter to the famous law, for it seems to imply that fire-damp expands into the workings under the influence of increased pressure and contracts when the pressure falls.

That a rising, and not, as previously held by many authorities, a falling barometer carried with it a danger of gaseous escapes in mines was suspected by Mr. Henry Harries in the 'seventies of last century. During the eleven years 1870–80 there were forty serious colliery explosions, of which only four, involving 275 deaths, occurred during periods of low atmospheric pressure, while the remaining thirty-six, causing a loss of 1830 lives, took place when the barometer was high or above normal. On December 8th, 1886, the deepest cyclone ever recorded in this country passed across the North of England. With the barometer at 27¼in., every gassy pit ought, according to the theory then widely held, to have been flooded with fire-damp to an extent never before experienced. The reports received from the mines showed, however, that there had been no increase or a complete absence of gas escapes. In 1881 Mr. Harries, with sufficient evidence already in his possession to justify him in his views, began issuing to the Press anonymous colliery warnings, urging miners to beware of gas escapes when the barometer was rising or high. He was at the time on the staff of the Meteorological Office in London. His views were in direct opposition to those of his official chief and by many his warnings were regarded as heretical and as reflecting seriously on the intelligence of mining officials. Yet he persisted with the issue of the warnings until his retirement in 1918. Opposition to the warnings and the theory on which they were based continued for many years. Between 1907 and 1911 there was, he states in a pamphlet on the subject which he has just issued, an apparently organised attack on the warnings. Whether they had anything to do with it or not, the fact remains that by 1907 the number and intensity of colliery explosions had greatly decreased. The strenuous attack upon them during the succeeding four years apparently was not without effect, for at a bound the statistics vaulted back to the level of the 'fifties and 'sixties of last century. With the cessation of active hostility, colliery explosions decreased almost to the vanishing point. These facts may depend merely upon coincidence or upon the influence of factors and developments entirely unconnected with the issue of Mr. Harries' warnings. We do not feel wholly satisfied with the statistical evidence which Mr. Harries advances in support of the efficacy of his warnings, for his figures are based on a slightly arbitrary selection of periods and classification of disasters. When, however, we turn to the scientific grounds upon which his theory rests, we cannot fail to recognise the strength of his case. Those interested in this aspect of the question will find it set forth in a paper by Mr. Harries published in the June, 1926, Geophysical Supplement to the "Monthly Notices" of the Royal Astronomical Society. Briefly put, the theory represents an application of the view held by several geophysicists that the elasticity of the earth's crust is sufficient to permit its level to vary by several inches under fluctuations of barometric pressure. Under anticyclonic conditions, the superincumbent strata are compressed, the vents on the outer surface close, the cracks and cleavages below open and the occluded gas is driven downwards into the workings. When the barometer falls, the surface vents open and the gas streams upwards through the relaxed strata from regions of high to regions of relatively low pressure. This view of the phenomenon is not wholly based on theory, but has been closely checked against practical experience. Mr. Harries has on the evidence he supplies definitely established that the rate of influx of gas into mine workings and the pressure of gas trapped in natural or artificially formed closed chambers below ground rise in strict correlation, although, as is to be expected, not altogether simultaneously, with an increase of the atmospheric pressure on the surface.

It has long been held by eminent geologists and others that the earth's crust is far from being in a state of repose, and that it is subject to daily, even hourly, variations of level and form. It responds, it is held, to tidal, thermal and other influences, just as if it were supported hydrostatically. World-wide experiments are about to be undertaken with a view to detecting and measuring the suspected movements and the consequential variations of longitude which they produce. Mr. Harries' theory—if, indeed, we may still call it a theory—is merely a logical extension of a general opinion accumulated over many years from the observation of many diverse phenomena. If the tides can cause rises and falls in the level of littoral regions, it is but natural to expect that variations in the weight of air pressing on the surface of the land should reproduce a similar and more widely spread result. A variation of 1in. of mercury in the barometric pressure represents a change of only 70 lb. per square foot in the load borne by the earth's surface, and, it has been objected, is much too small to produce the breathing effect attributed to it by Mr. Harries. Builders commonly load their foundations with a pressure of 1 ton per square foot, and engineers sometimes employ foundation pressures as high as 10 tons to the square foot. Surely, it may be said, the fact that such loads are applied to the earth's crust without disaster definitely disproves the contention that changes of load produced by variations of atmospheric pressure can cause the earth's level to breathe even to the small extent required to satisfy Mr. Harries' theory. The cases are not comparable. In one we are dealing with local loads; in the other, with a load spread over the whole of the land surface. It is total load rather than pressure per square foot that enters into the question. A change of 1in. in the average pressure over the British Isles removes from or applies to the land surface a load of some 106,000,000,000 tons. The weight of the heaviest building or engineering structure ever erected is quite negligible, by comparison, in its distributed effect. Moreover, the builder's or engineer's work consists from the geophysical point of view mainly of a loading of the earth's surface at one point at the expense of an unloading at some relatively adjacent point. Changes of atmospheric pressure, other than purely local variations, are equivalent to net additions to or subtractions from the load supported. The breathing of the earth's crust is not, and is not likely to become a factor of direct engineering importance. But it is most desirable that engineers should recognise that it exists, and that in mining operations it passes at once from a subject of academic interest to one of vital human concern.

The Engineer and the Foundry.

We have repeatedly, in these columns, pleaded for closer co-operation and understanding between engineer and metallurgist, and in our Supplement, The Metallurgist, we hope that we contribute something towards the furtherance of that understanding and co-operation. In no class of metallurgical work, however, is that mutual relationship of metallurgist and engineer more strikingly exemplified than in regard to the foundry. Whether it deals with iron, steel, or non-ferrous metals, the foundry has to produce the objects which the engineer requires, and they must conform not only to the outward shape which is defined by the drawings, but must also meet the requirements of the specification in respect of physical properties. It is thus clearly an easy matter for the engineer, on the one hand, to demand from the foundry something that cannot be produced, at all events under commercial conditions, while, on the other hand, the founder may either misinterpret the engineer's demands or fail to supply what is fairly asked of him. While no doubt the majority of engineers and founders work harmoniously together, failures and difficulties occur from time to time, and it is perhaps worth while to consider the conditions that give rise to them.

On the side of the engineer, difficulties are most frequently caused by lack of sufficient knowledge of the precise properties of the material specified for the casting or of the conditions with regard to shrinkage which must be met if a sound casting is to result. To take the latter first, different metals and alloys demand widely different treatment; a casting of a particularly difficult shape that can be successfully produced, for example, in cast iron could not be readily obtained without "draws" or shrinkage cracks in an aluminium alloy. Or, again, the degree of soundness that could be reasonably expected of a brass casting might prove difficult to obtain if the metal were changed to pure copper. The fact that the design of castings must be to some extent adapted to the nature of the metal in which they are to be cast is a fundamental principle which the designer does not always seem to bear in mind. The question of the properties of the material of the finished casting is a matter of equal importance. It is true that, as a rule, acceptance tests of castings, where they are bought by one firm from another, are usually based on B.E.S.A. specifications in which the properties are defined in terms of carefully specified test bars. The engineer, however, frequently uses castings made in the foundry of his own firm, and in designing such castings naturally assumes a value for their strength. Provided it is a reasonable value, this is right and satisfactory, but it is not so obvious what really constitutes a reasonable value. The tensile strength, for instance, which can be specified for a test bar, whether cast in sand or chill, is by no means necessarily attained in all or any parts of the casting. If the casting has parts differing

widely in cross section, the thinnest parts may prove to be stronger and the thickest parts much weaker than the test bar. In some cases the strength of the thickest parts of a casting may not be more than one-third of that of the test bar. If, as we believe is sometimes done, the engineer has taken the test figures from a B.E.S.A. or other good specification as his guide, and looks for similar strength in his casting, he is bound to meet with serious disappointment; he will be inclined to blame either the foundry or the specification. In reality he has failed to appreciate the real meaning of such specifications, which cannot and should not be used as direct guides to design. The founder, on the other hand, is equally often at fault. A difficult casting is apt to be looked upon as a freak or a mistake in design, instead of being treated as an interesting problem to be solved by the skill and knowledge of the founder and the metallurgist. A new alloy which, perhaps, the engineer wishes to try in view of its valuable properties is "turned down" as useless because it "cannot be cast," whereas, again, it requires study and care to bring it to practical success. It is, of course, much easier for the founder to say that the new material is "not practical," and all too easy for the engineer to accept that verdict. But what is the result? There are, in reality, few alloys which cannot be satisfactorily cast if the proper method of treating them is studied. If one founder refuses to do this, another will succeed, and often enough the other is in some foreign country. Ultimately, it means that progress is achieved elsewhere, and the man who is too ready to turn down something new and troublesome finds himself left behind.

If this occurs in a firm which is essentially a foundry, the firm has only itself to blame for the consequences. Often, however, the foundry is part of a great engineering works—too often looked upon as a "mere subsidiary"—and then the blame lies upon the organisation which allows the foundry to lag behind the general level of the plant. Engineers and designers would not be worthy of leading posts in a great engineering concern if they did not keep themselves in touch with current progress, and their products up to the level of the best that can be attained. It is a matter of serious importance that this same high level should be attained by the foundry. The men who are responsible for organisation are frequently essentially engineers. If these engineers fail to appreciate the metallurgical aspects of their work, the foundry suffers and with it the efficiency of the whole concern. It is a striking instance of the need of mutual understanding and appreciation between engineers and metallurgists.

Breakdowns of Steam Turbines and Engines.

THERE will never be any lack of interest in accidents. In their minor forms they attract attention by breaking the ordered monotony of life, while in graver cases they strike the imagination as the exaction by Nature of some sudden and severe penalty for carelessness or ignorance. Accidents indeed are the fees paid for knowledge, and every time the lesson is forgotten the fee is liable to be paid again. Fortunately men can learn at second hand, and engineers can have few better text-books than reports such as those issued annually by the British Engine Boiler and Electrical Insurance Company. In these reports are discussed the most noteworthy breakdowns which have come under the notice of the company's inspectors during the year. Being exact accounts of the failures and troubles which do occur in practice, recorded under the supervision of Mr. Michael Longridge, the company's chief engineer, the reports are invaluable to all students of design, especially as they often illustrate the importance of those intangible and qualitative factors which no formulas can take account of. If some means could be found of compelling designers to reflect upon the results of practical experience, as recorded by the company, we should probably have better machinery and fewer accidents.

In the report for 1925 seven cases of breakdowns of steam turbines are dealt with. Four of them were due to blading failures, caused either by water or dirt in the steam. In the case of one turbine, an impulse machine of 1500 kilowatts capacity, which had been running less than two years, the steel vanes in the cast iron nozzle-box had been worn to a knife edge, to such a degree, in fact, that pieces of metal had been torn away and had damaged the blading. The cutting action of the steam had, moreover, deeply scored the nozzle block and serious erosion of the leading edges of the blades had taken place. The steam entered the turbine at 120 lb. pressure, and the trouble was primarily due to its wetness, although a certain amount of sediment was also carried over from the boilers in too finely divided a state to be arrested by the strainer.

What might have been an exceedingly nasty accident was averted by the vigilance of an engineer-in-charge, who noticed cracks in one of the wheels of a 3000-revolution impulse turbine when the latter was opened up for its periodical inspection. The wheel, which was 40in. diameter, had two ¾in. holes through it, drilled opposite each other on a circle 9¾in. diameter and just about where the tapered profile of the wheel changed. The object of these holes, which were additional to the ordinary six large balancing holes, was to facilitate the withdrawal of the wheel from the shaft. Circumferential cracks, one 1¼in. long and the other 6in. long, had started from opposite sides of one of the small holes and had travelled approximately along the line where the two tapers of the wheel joined each other. The tip speed of the wheel in question was by no means excessive, being about 524ft. per second, but quite high enough for the possibility of a disastrous explosion, had not the cracks been noticed in time.

The aggregate of the faults committed in the design would seem enough to make any turbine wheel crack. In the first place, calculations showed that the natural periodicity of the disc was almost synchronous with the impulses given to it by the steam from the nozzles. This had set up axial vibrations which had evidently caused the disc to foul the nozzles. Further, the tendency for a crack to occur was aggravated by the unsatisfactory design and material of the disc. The change in profile, already referred to, was far too abrupt, and the conditions were made worse by the fact that the surface had even been undercut at this point in machining. The withdrawing holes were incorrectly situated on a line of high stress and sudden change of section, the keyways in the bore had sharp corners, and the radius at the junction of the disc with the boss was too small. In addition to all these faults the microstructure of the wheel was that of a severely overheated material, which never should have been used in its existing condition, as it could have been perfectly restored by suitable heat treatment.

The errors of the designer in this instance were partly due to want of mathematical knowledge and partly to lack of common sense. The latter, unfortunately, cannot be derived from books, and it is more than ever needed in everyday points of design to which mathematics are not applicable. An example of such design is in connection with the question of ribs on castings, and especially on castings which are exposed to changes of temperature. A 1600-kilowatt impulse turbine, mentioned in the report, was provided with ribs 1in. thick and 4½in. deep, connecting the high-pressure gland sleeve with the annular steam belt of the cast iron casing. Where these ribs joined the gland-sleeve cracks developed which opened out to 25 mils at their ends when the turbine was at work. They worked through the full depth of the ribs till they came to the body of the casting, and then started travelling round the fillet at the end of the gland sleeve. In time the casing would certainly have failed, as the cracks were extending rapidly. The utter needlessness of the ribs, the existence of which had caused all the trouble, was shown by the fact that they were subsequently cut away almost entirely, the affected part being completely removed. The cracked surface of the fillet was also chipped away, and with those alterations the turbine had run, at the date of the report, for twelve months without further trouble. Two other cases of ribs in turbine casings cracking and being cut away to effect a cure are given in the report, and we recently saw a 10,000-kilowatt turbine on the Continent where the same thing had had to be done. It is the absence of that sound constructive instinct developed by practical knowledge that results in faulty design of the kind mentioned, and the prevalence of such design is a reflection on our methods of training.

In connection with reciprocating steam engines two cases of connecting-rod breakage are noted. The first is that of the high-pressure rod of a large horizontal cross compound engine running at 40 revolutions per minute. The rods were of wrought iron, forked at the small ends, which were constructed with palms carrying split brasses secured by bolts. One day an unaccustomed tapping noise was heard, coming from the small end of the high-pressure rod. As the brasses were not loose and the noise continued the engine was shut down, when it was found that one side of the jaw of the rod was nearly broken off. An examination of the material in the company's laboratory disclosed nothing of a defective nature, but as the rod had run for fifty-two years and endured about 360 million reversals of stress, its failure was not considered surprising. It is, however, fair to ask why a connecting-rod which will run for fifty-two years should not run indefinitely without fracture. The company seems to think that old age alone is not sufficient to account for the breakage, and it mentions possibilities of overstrain having occurred during recent years, owing to the breakage of the bolts.

The other connecting-rod which failed had been working for about twenty years in a horizontal tandem compound engine driving a factory. Unfortunately, it gave no warning, and before steam could be shut off the engine was as complete a wreck as is usual in such cases. The rod, which was of wrought iron, had a solid box end to contain the crank pin brasses, and this box end broke through the top and bottom sides simultaneously at a sharp change in section where the corners of the octagon-shaped end brass fitted. It was evident that the big end had been knocking for some time, and though the design was blameable, the fact that it had stood for twenty years without fracture is worth recording. The two crank pins which broke were both shrunk into the crank webs, and each was provided with a solid collar entering a recess on the web. The company has for years advised makers to use crank pins without collars and to obtain the radius for the brasses to bear against by making the shank inside the web of larger diameter than the bearing part of the pin. The justification for this advice is to be found in the fact that both the pins in question broke through the shank just behind the collars. One had indeed made 149 million revolutions, with a calculated maximum stress as high as 9·7 tons per square inch, and the other had made 272 million revolutions with a maximum stress of 5·16 tons per square inch; but Nemesis eventually overtook the designers for the fault of using collars.

The two instances of shaft failure which are discussed were fortunately both discovered before actual rupture occurred. The first of them related to the sudden and dangerous extension of an old-standing longitudinal crack in a crank shaft journal 9in. diameter. The company's inspector noticed the imminence of trouble and had the shaft replaced in time. It had been running fifty-four years, during which time it had made 315 million revolutions under a maximum stress, due to bending and twisting, of 4·8 tons per square inch. The other failure was that of a second motion shaft, which cracked in one of its journal necks 8¾in. diameter, after forty years' service, during which it had endured 300 million cycles of stress. The shaft was of poor quality wrought iron and the crack started in a slag seam.

Two large vertical engines were thoroughly wrecked by the breakage of bolts in the big ends of the connecting-rod. In one case a bolt 2½in. diameter, carrying the brasses of a marine-ended rod, broke across the threaded part. The steel was of poor quality and the absence of any radius at the root of the threads made fracture only a question of time, although the engine had been running since 1903. In the other engine a 2in. bolt failed at a sharp fillet, its fracture being assisted by impact bending stresses, due to it not fitting properly. Another fair-sized horizontal engine was wrecked by injection water from a jet condenser getting into the low-pressure cylinder. The separately driven air pump was 90ft. away from the engine, and for nearly a quarter of a century the pump had been shut down safely by co-ordination between two operators. One day, however, the driver of the main engine failed to open his hand-operated vacuum breaker when the air pump was shut down and the inevitable consequences happened. An automatic vacuum breaker would have saved the situation and one was subsequently fitted.

Water in the cylinder was also the cause of the wreckage of an old beam engine after sixty years' service. The neglect of steam traps and the bad arrangement of steam piping, the possible serious consequences of which had been pointed out by the company on several occasions, resulted in a shot of water too great for the relief valves to cope with, and at long last retribution, *claudo pede*, overtook those responsible for the lay-out.

BOOKS RECEIVED.

A Book About Mechanical Marvels. By E. Protheroe. London: The Epworth Press, 25–35, City-road, E.C. 1. Price 2s. net.

The Discoverer of Gas Lighting. By Dr. C. Carpenter. London: Walter King, Ltd., 11, Bolt-court, E.C. 4. Price 2s. and 3s. 6d. net.

Foundry Practice. Third edition. By R. H. Palmer. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

From Slip to Sea. By A. C. Hardy. Glasgow: James Brown and Son (Glasgow), Ltd., 52, Darnley-street, Pollokshields. Price 10s. 6d. net.

The Location of Mineral Fields. By M. H. Haddock. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, E.C. 4. Price 9s. 6d. net.

Axle Loads, Wheel Diameter and Railhead Dimensions. By A. F. Harvey. Calcutta: Government of India Central Publication Branch. Price 4d. net.

Textile Bleaching, Dying, Printing and Finishing Machinery. By A. J. Hall. London: Ernest Benn, Ltd., 8, Bouverie-street, E.C. 4. Price 50s. net.

Elementary Heat and Heat Engines. By F. G. R. Wilkins. London: Humphrey Milford, Oxford University Press, Falcon-square, E.C. 1. Price 7s. 6d. net.

Statically Indeterminate Stresses. By J. I. Parcel and G. A. Maney. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Belt Conveyors and Belt Elevators. Second edition. By F. V. Hetzel. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. net.

Middlesbrough Royal Exchange Year-book, 1926. Middlesbrough: The Middlesbrough Exchange Company, Ltd., Royal Exchange. Price 2s. 6d. net to non-members.

Final Report of the Peat Committee Appointed Jointly by the Governments of the Dominion of Canada and the Province of Ontario. By B. F. Haanel. Ontario: Mines Branch, Department of Mines, Canada.

Some Problems in Hydraulics and River Engineering.

By E. S. BELLASIS, M. Inst. C.E.

For some seventy years there have been projects for constructing large perennial canals with their off-takes from the Indus, just above the Sukkur gorge—Fig. 1. A barrage across the Indus has formed part of the scheme. The canals are intended to substitute perennial irrigation for inundation canal irrigation in great areas of land, and also to supply water to tracts at present unirrigated. A project was worked out and sent home for the sanction of the Secretary of State for India in 1910. It was not sanctioned, chiefly because it was doubtful whether it would be a financial success. It was referred to a committee of engineers in London. They suggested, among other things, that the best site for the barrage might possibly be below the gorge instead of above it. A site below the gorge has actually been selected, and the project has lately been sanctioned and work begun. The sanctioned scheme has been subjected to severe criticism by Dr. Summers, chiefly with reference to financial considerations,[1] and by Mr. F. W. Woods on engineering matters.[2] The criticisms have been replied to in a volume of 122 pages.[3] The present article deals with a few engineering questions which have not been fully settled or as to which criticism has been resumed.

The discharge of the river when in high flood is about 1,200,000 cubic feet per second. The discharge in the flood allowed for in the project is 1,500,000 cubic feet per second. The great flood of 1858 is said to have attained that figure. The first question is whether the barrage will tend to increase the danger of the Indus taking a new course and abandoning the gorge.

Changes in Rivers.

The tendency of a river in an alluvial plain, when the velocity of the stream is too high for the channel, is to work itself into bends and so to reduce the gradient. An obstruction at, say, the right bank causes an indentation in the left bank, and a slight curve. That causes a set of the current against the right bank lower down. Thus the bends tend to occur alternately in opposite directions. The stream wears away the concave bank and silts at the convex bank, and thus the bends become more pronounced. They may become loops—that is, the length of the bend may be very much greater than the chord across the neck of land.

The slope along the chord of a bend or loop is, of course, comparatively steep. During a high flood the water which spills over the country may scour out a channel along the chord, or other line of steep water gradient, and produce an "avulsion" of the stream, the old channel silting up or becoming a side channel. Except where the channel forms pronounced loops—as in the lower reaches of the Mississippi—avulsions are rare. The flood water is generally shallow. Vegetation obstructs its movement, and also renders the soil difficult to scour away. The floods may be of short duration. Fig. 1 shows an avulsion which occurred in 1906 at mile 17 below the Sukkur gorge. In going away from the river the country often falls. It rises again towards the watershed. There is thus a depression parallel to the river. Flood water may flow for great distances along such depressions, but avulsions rarely occur into them. An avulsion other than into such a depression or back into the river—in fact, right across country—has occurred now and then under artificial conditions. In China a river having been embanked on both sides, having then raised its bed by silt deposits and the embankments having been raised, the bed of the river at last rose to ground level.

The Punjab rivers have comparatively steep slopes, high velocities and small depths of water. They can carry—in virtue of Kennedy's well-known law—high charges of silt. The river channel remains fairly straight. It is so wide that the stream becomes crooked by wandering about in the channel. It frequently straightens itself by taking a fresh course down a side channel or "creek" or across an easily eroded sandbank. That is a very different thing from an avulsion where ordinary country has to be scoured away.

A peculiarity of the Indus is that it tends to work to the west. In the course of a five-year or ten-year period any short reach may have shifted eastwards or westwards, but a long reach is often found to have shifted westwards on the whole. This tendency has, for some fifty years at least, been marked in a 70-mile reach in the Punjab near Dera Ghazi Khan. In this reach it has moved 2 or 3 miles westwards, destroying the marginal flood embankments—which are always set back and not made close to the river—and canal regulating bridges. Protection of the bank of the main stream by spurs or the like would be far too expensive. When the main stream is not near the western bank, long "reclamation embankments" or "groynes" are run out from it—in the low-water season—across the sandbanks and across any creeks which are dry or are small enough. These groynes encourage silting and—as long as they exist—tend to prevent the main stream from breaking down the creeks. In spite of them, the river works somewhat to the west. To protect the town of Dera Ghazi Khan, the left bank of the river was, in 1889, lined by an embankment protected by heavy stone pitching, similar in type to the curved "guide banks" used at the great railway bridges, a mile long. The embankment was, however, straight. Funds did not admit of its being carried further upstream and curved landwards. The river cut in upstream of it, and, though it had a strong stone "head," gradually destroyed it and the town. The causes of the westward tendency of the Indus are not known. In the 70-mile reach above mentioned, the river once flowed to the westward of its present channel. It is said that about 400 years ago it was moving eastwards.

But we are now concerned with Sind. While yet in the Punjab the rivers have all merged into the Indus; before the Indus has reached the neighbourhood of Sukkur its character has changed. The slope of the country has become less, and so has the width of the channel. The river flows generally in one stream, and it cannot make itself very crooked within its channel. The channel itself becomes crooked just as in the case of countless British and other rivers. It constantly shifts its position by scouring at one side and silting at the other. It tends to move somewhat westwards. The Sukkur gorge is of rock and lies near the western end of a small range of hills. The narrow part of the gorge is a mile long, and has an island—also of rock—in it. Everywhere else for scores of miles in either direction the river is traversing alluvial plains. In whatever manner and to whatever extent the river upstream of the gorge has shifted its course, the lower end has always remained in the gorge. There was, of old, a fear that the river might some day abandon the gorge and take a course to the westward of it, cutting across the railway line and the lines of the right bank canals. The fear was first expressed by an official who was not an engineer. To the non-professional mind there is always confusion between a flood and an avulsion. The fear was evidently not shared by the engineers who designed the railway line and bridge.

If in any river we consider a 50-mile reach in which the general conditions are fairly uniform, it will not be found that one-half of the reach—say, the lower one—contains all the bends and the other none. The causes producing the bends are the same in both halves. The bends will in the end tend to become equal in the two halves. Similarly, the causes producing bends operate, as already explained, in both directions. The river swings this way and that. It is rare for it to lengthen itself by one very large bend taking it far out of its general course. The plan shows that in the past the river above Sukkur has shifted this way and that. There is no evidence that it has ever adopted any course approximating to that marked A C M. It is most improbable that it will adopt such a course. It would involve a great excess of bends in the lower half of the reach K M and a great deviation at C from the general line K M. Whatever westward tendency the river has, it has no known tendency to work to the south.

The Begari and other marginal embankments are for the purpose of preventing floods from spreading over the country. They have nothing to do with the ordinary shifting of the river. The river frequently shifts so as to cut into an embankment. In that case another is made in its rear. This is constantly done both in the Punjab and in Sind. But until an embankment is cut into or breached in a flood an avulsion cannot occur. The avulsion of 1906 below Sukkur could, if necessary, have been prevented by embankments. Breaches in the Indus embankments sometimes occur. They are generally closed before long. They never cause avulsions.

If the river ever got as far as a line such as A D M it might be desirable to restrain it by guide banks at suitable places. But probably such costly measures would be deferred and the river would cease to move nearer to H. Of course, there would be an embankment on some such line as C M. As long as it stood it would prevent an avulsion. Breaches in it would be specially guarded against and could be prevented. There would also be special arrangements for closing any breach if it did occur. The danger of avulsion as matters now stand is well-nigh negligible.

The question now is whether the barrages will cause increased danger. The barrage just above the gorge was designed to hold up the water in the lower stages of the river to R.L. 192·0[4]. The flood level here is 202·3. The increased danger of avulsion is nil. In the new project the canal bed levels are placed higher than before. This reduces the cost of the canals, but requires far more heading up in the river.

The sanctioned barrage at B, Sir Thomas Ward's site, is designed to hold up the water to R.L. 194·5, which is very slightly above the average flood level of July. In June and September an average heading up of about 1·5ft. will be necessary, in May of 4·5ft., in winter of 8ft. These "affluxes," of course, get less in going upstream and vanish at points far upstream. They merely prolong the period of moderate flood level and to a slight extent the period of careful watching of the flood embankments. This can be faced. Thus, under the existing scheme, the direct effect of the heading up will be to increase by an appreciable, but very small, amount a danger which is at present almost negligible. The question of indirect danger owing to silt deposit in the river will be considered below.

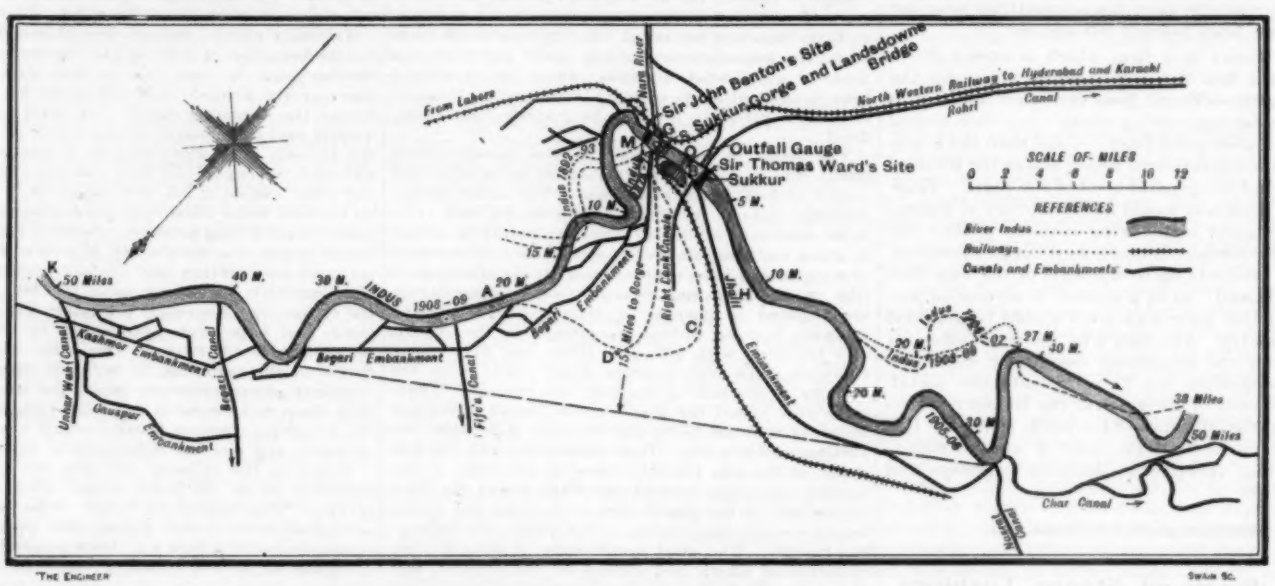

FIG. 1—MAP SHOWING POSITION OF SUKKUR BARRAGE

(1) "The Sukkur Barrage Project and Empire Cotton," by T. Summers, D.Sc., C.I.E. 1921.

(2) "*Journal* of the Royal Society of Arts," Vol. LXX., pages 705–736. (F. W. Woods, C.I.E.).

"*The Times Trade and Engineering Supplement*," August 15th and December 5th, 1925. (F. W. Woods, C.I.E.)

(3) "Sukkur Barrage Project—Joint Notes," by F. St. J. Gebbie (Inspector-General of Irrigation in India), and A. A. Musto. 1923.

[4] R.L.—Reduced level. An Indian official term signifying "reduced to sea level."

The Barrage Sites.

The approximate width of the waterway in the rock gorge G S is 1400ft., at S—Sadhbelo—it is 2200ft. It then gradually widens out to 3300ft. at O, the "Outfall Site," and to 5300ft. at B, the "Barrage Site." The banks in the reach S B are high and of hard clay and never alter. The whole reach G B is thus a stable reach and of immense value. The railway bridge neither has nor needs guide banks. The river is always compelled to flow through the gorge, but it can, and usually does, enter the gorge obliquely. A barrage just above the gorge at M or higher up would have needed guide banks in order that the water might be compelled to flow straight on to it and not obliquely. The construction of the guide banks would have been costly and their upkeep costly. The site B has been adopted because no guide banks will be required, and also because very heavy and expensive rock cuttings for the canals—as well as bridges and other works near the town—are avoided. The loss of head is negligible. The great fall in the water surface from G to O occurs only in floods. This is because the gorge is narrow and its sides steep. Everywhere else the stream as it rises can spread out and increase its width. But it is not in the flood season that there is difficulty in getting water into the canals and that the barrage gates have to be used. As regards water level the upstream barrage site has no particular advantage over the downstream site.

The high velocity in the gorge G S during the flood season causes scour of the bed down to the rock. It has been argued that the river water must be charged with this silt, and that the heavy silt usually present in the lower layers of the stream or rolled along the bed must also be churned up so that the canals taken off at B, even though their supplies are drawn off well above the river bed level, must silt. It has been replied that below S the swirling soon ceases, normal conditions become restored and the upper water at B contains no unusual proportion of silt. The two miles from S to B suffices.

On the right bank three canals will take off and at first run side by side. On the left bank one canal will supply the old **Nara River** channel and one, not on the plan, will be west of the Rohri Canal. This last is to be the largest and is typical of the others. Its bed level is to be at R.L. 180, full supply level 193 and the top of the masonry sill, over which the inflowing water will flow, 182. The bed width is to be 253ft. and the full discharge 10,992 cubic feet per second. The level of the floor of the barrage is to be 176. The cost of this long barrage will be less than that of a short one above the gorge in deep water. The abutments of the barrage will contract the width of the river from 5300ft. to 4680ft. The piers—there will be sixty-six spans of 60ft. each—will reduce it to 3960ft. This will of itself cause a heading up of about 1ft. during high floods.

Silt and Scour.

The width of the Indus at B being greater than at O, the average bed level might be expected to be somewhat higher at B. The river bed is, of course, shifting, except perhaps in winter, and the matter is not simple. The bed level at B is approximately about a foot higher than at O. All water levels and bed levels mentioned herein or shown in Fig. 2 are averages—generally monthly averages—unless the contrary is stated or implied. The bed level at B is of importance in connection with possible silt deposits in the canals. Scour during floods, especially rising floods, is a usual occurrence in rivers. It frequently occurs at O during June, July and August. The river is then on the whole rising. The approximate discharges for June, July and August are respectively 230,000, 310,000 and 460,000 cubic feet per second, and the bed levels 180·7, 179·1 and 177·2. No one could say offhand whether or not this scour extends to B.

In Wood's criticism of the scheme it is stated that the barrage site is that of a shoal "formed by material scooped out of the river bed by the currents rushing through the gorge and deposited at that site," and it is attempted to show that silt deposit at B will be heavy and dangerous for the canals. The scour at O during June, July and August is mentioned. The only figures comparing the two sites O and B are for two days, July 31st and 17th, 1918. The bed at B was nearly the same on both days, and was about 180·22. At O the levels were 177·89 and 174·61, the discharges being about 261,000 and 463,000 cubic feet per second respectively. Probably the bed at O was changing rapidly. From the above it is inferred that the greater the discharge the higher the bed level at B. There cannot possibly be a general law to this effect. It would imply that an exceptionally heavy flood, instead of keeping the channel at B open for itself, would silt it up and be unable to get away. The project engineers show that the average bed level at B is about 180, and that behind the sill there will be gates which will rise when the river rises and form silt-excluding sills the level of which may be as high as 192·5. They also correctly state that by raising the barrage gates, say, 1ft., they can produce a rush of water under them, and so scour away silt down to the floor. There is no reason, however, to suppose that the flow of approach would concentrate—as they infer—along the river bed.

In the case of a sharp-edged orifice in the side of a reservoir, it is the water flowing along the side from all directions which causes contraction. In the barrage orifice the flow along the bed is aided by velocity of approach, and it would be stronger than other flows, but would not exclude them. The silt close to the barrage would, of course, be scoured away. Further upstream the silt in scouring away may form a long slope, say, 1 in 40. If its depth was 4ft., the scour would not extend upstream from the gates more than perhaps 160ft., which is far less than the width of the Rohri canal head. It may be possible by careful manipulation of the gates to prevent any heavy deposits near the canal heads. But the rising sills should serve to exclude silt from the canals.

The latest information is of much interest. Frequent observations of the discharge and silt contents of the river water at S, O and B, made in 1925—from July 7th—show that when there is scour or silting in S O, there is the opposite action, not generally very different in amount, in O B. In S O there was 3·8ft. of silting from July 7th to 14th, then 6·2ft. of scour in the higher floods in July and August, alternate silting and scour in the rapidly falling river in late August and then continuous silting, totalling 4·8ft., as the river fell till the middle of November, the action after October 15th being slight.

This wave-like procession, or apparent procession, of masses of silt is characteristic of shifting rivers. The river action depends not only on the local depths and velocities, but on the quantity and nature of the silt which the stream is already transporting. There is, throughout the course of the river, an endless variety of conditions. It begins with the great and frequent changes in the rainfall near its sources in the mountains. If at any point in its course the stream cannot carry or roll all its silt a shoal may begin to form. Before long the velocity over the shoal increases, and it begins to scour away. In the end the shoal may disappear. Another may form lower down. That is the river's method of procedure. It can in this way move on everything, step by step.

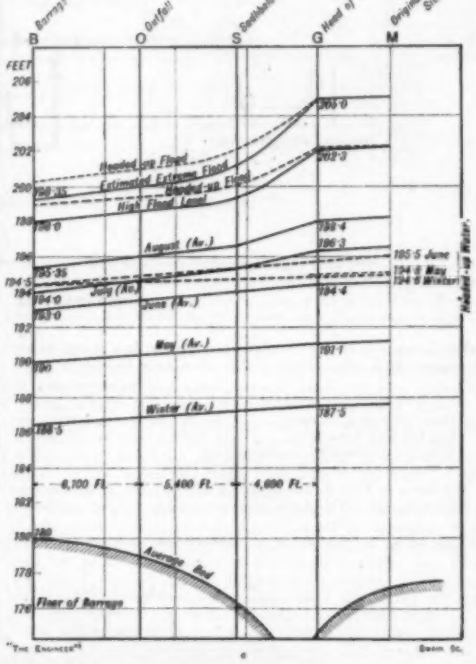

FIG. 2—WATER AND BED LEVELS IN THE INDUS

Canals Without a Barrage.

It has been suggested by Woods that the canals should be made without any barrage at all, the bed of the Rohri canal being lowered 5ft., and its full supply level brought down to below the average winter level of the river. This, the project engineers point out, would not be below the occasional river winter level. There would now and then be great deficiencies in the supply. Moreover—and this has not been mentioned by either party to the dispute—the bed of the Indus is never level across, and the stream in winter is not necessarily near either bank. In the absence of a barrage, the supplies could not with any certainty be got into the canals. One great reason for substituting perennial for inundation canals is certainty of supply. The Upper Jhelum canal, quoted as one which works without a weir or barrage, does not take out of a river with a soft shifting channel. Some of the area on the Indus right bank canals could not, without a barrage, be irrigated at all. It would be necessary to give them a separate canal taking out many miles upstream at K, where there is no stable channel. It has even been suggested that all the offtakes might be at K. There is not the slightest reason to suppose that that would be an improvement on the project as it now stands. In any case, the subject would need prolonged investigation.

Backwater Problems.

The heading up in floods of 1ft., due to the barrage piers, of course, diminishes steadily in going upstream. The diminution is more rapid the steeper the surface slope. It is stated that the heading up will become zero before G is reached. That seems to be nearly correct. At any particular cross section in a wide channel, the surface slope S is altered by heading up, so as to be nearly inversely as d^3, d being the mean depth of water in the cross section.[5] This applies to any short and fairly uniform, or uniformly changing, reach. At B d is increased, say, from 18ft. to 19ft., and S is therefore reduced from about $^1/_{9456}$ to $^1/_{11500}$. The heading up at O is perhaps ·88ft. Now d increases and the relative change in S is less. From S to G the increase in d is still greater, at least in the main gorge. At G there will perhaps be ·20ft. of heading up, and at M ·1ft. Above M the river banks are low and the embankments high, and the danger of avulsion is less negligible than elsewhere. The heading up will not make it become other than negligible.

The following statement appears in the criticism:—"A flood of 1,500,000 cubic feet per second passing through a waterway 3960ft. wide, with floor level 176 and flood level 199 downstream of it, may need an afflux of 2¼ft. to pass it through." The 2¼ft. appears to have been arrived at by omitting to allow for velocity of approach. The 1ft. allowed in the project seems to be correct. The passage—it deals with the existing fall of 5ft. at estimated extreme flood between G and O, and Bukkur is the same place as G—continues:—"This, magnified upstreamwards, in the narrowing channel, might increase to 3·5ft. at Bukkur over and above the 5ft. afflux which is its liability independent of the barrage." The reader may like to try and sketch this on the longitudinal section.

When the river is at its lowest, it will be headed up, say, 8ft. at the barrage. The backwater will extend for some 20 miles upstream. There will be silt deposit in the river channel, and that is by some considered to be a grave defect in the scheme and to increase the danger of avulsion. It is argued that the deposits may still be there when the high floods come, and that the height of the floods may thus be increased. The quantity of silt carried by the Indus at the outfall site has been carefully observed for many years. The quantity carried past Sukkur in a year may be as much as 10,000 million cubic feet, which, if deposited, would be equivalent to a depth of some 20ft. over the whole river channel for 20 miles. The surface slopes, when there is heading up, are shown in Fig. 2 by dotted lines. In the six winter months the slope is very flat, and V is about half the normal figure, but there is then very little silt. In May and October there is rather more silt, but V will now be higher. The sand rolled along the bed is probably much less than that carried. In winter there is little. At other times it will pass under the gates, which will be partly raised. The reductions in V, however, reduce the rolling power of the stream as well as its carrying power. The total quantity of silt to be dealt with is thus greater than that stated above. In the whole of the eight months, October to May, the silt deposit will probably be about 1·5ft. over the 20 miles of river.

In June and September heading up—with V reduced from normal by some 22 per cent.—will alternate with moderate floods in which the gates will be raised. In July and August the floods will generally pass freely. It is in these four flood months that the vast bulk of the silt is transported.

It is not possible to calculate the quantity of silt which the stream will deposit when headed up, but general experience enables its action to be foretold. If a given volume of water is available for cleaning out a drain the best way to utilise it is generally to send it down in flushes. In the case of a "regulator" in a canal, holding up the water and letting it in with a rush may, if frequently repeated, have some effect in moving silt on in the downstream reach. In the upstream reach it is found that silt which is deposited owing to the holding up of the water is generally washed out when the holding up ceases.[6] The greatest depth of silt is at the regulator, and a sudden drop in the bed occurs there. That eminently favours quick removal by a rush of water. And the ponded up water is there to cause the rush. The supply being steady, the holding up should perhaps extend over not more than half the total time. In like manner, the Indus will free itself from the silt deposited by the holdings up. These will extend over more than half the time, but not over a period covering more than half the total discharge of water or silt.

Only the early floods—say, those in May or June—will be made higher by the deposits. After them will come the prodigious power of the big floods. The rushes of water which are required will be there. The project engineers and others acquainted with the Indus have seen it in flood. They have seen how it can remove the deposits which already occur above the gorge. There is no fear that its bed will be permanently raised. The scheme has been called risky. It is bold, but safe.

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[5] See "Hydraulics with Working Tables," by E. S. Bellasis. Fourth edition. 1924. (Cap. VII. Art. 10.)

[6] See "River and Canal Engineering," by E. S. Bellasis. Second edition. 1924. (Cap. IV. Art. 1.)

The Italian Pig Iron Industry.

We extract the following from the survey of Italian trade and industry, dated August 1st, which is issued by the Association of Italian Corporations and the General Fascist Confederation of Italian Industries :—

"The Council of Ministers at its meeting of June 30th ult., stressed the need for the metal trades to utilise more fully Italian ores and, when possible, fuels, and also the desirability of increasing the output of pig iron for castings and refinings, with a view to reducing the heavy imports of these products which in 1925 cost the country 125·4 million lire, and 52·8 million during the first five months of 1926.

"This recommendation was immediately followed by consultations between the Ministers of National Economy and of Finance and the representatives of the metal trades. The understanding arrived at as a result of these meetings provides that the Government will relax for the present the restrictions placed on the working of the Elban iron mines, and that the industry, by a fuller use of national ores and recourse on a larger scale to the use of pyrite ash as raw material, will intensify the production of pig iron so as to reduce by one-fourth to one-fifth import requirements. The importance of such action in relation to the trade balance is evident when it is borne in mind that the total imports of steel and iron were valued at approximately 1270 million lire in 1925.

"The iron and steel masters have undertaken to keep prices at the level prevailing on May 5th ult., and this notwithstanding the heavy rise in the cost of raw material, more especially of coal.

"In the interests of the industry a National Co-ordinating Committee has been formed on which the Government is represented. Italy will thus have her iron and steel cartel for the protection of national interests in relation to coal and iron combines which have recently had such a notable development in other countries.

"This understanding, arrived at with a view to reducing costs in the general interest of Italian trade, especially of the engineering industries, will play an important part in determining the organisation of the metal industry. A cheaper product can only be secured by pouring the liquid metal direct from the blast into the steel furnaces, thus securing its transformation into the semi-manufactured article without further consumption of fuel for reheating. Cheap steel is thus secured by means now generally adopted by the great metal industries of the world. Undoubtedly the introduction of this improved technique implies considerable effort on the part of Italian producers, but it is an effort which will mark a further important development in the national metal industries.

"The latest available data show that the output of steel amounted in Italy to 149,000 tons in May, 1926, as against 133,000 in May, 1925. The figures for previous months of the current year were 140,000 tons in April, 128,000 tons in March, 134,000 tons in February, and 131,000 tons in January.

"The output of pig iron amounted to 427,000 tons in 1913 ; it fell to 267,000 tons in 1924, and once more rose to an estimated 467,000 tons in 1925. This output was obtained almost entirely from coke blast-furnaces, 5640 tons only being the output of electric blast-furnaces. Of the 466,492 tons thus obtained 368,186 tons came from the five furnaces kept in blast by the Elba and Ilva companies, of which 211,913 tons were the output of the last six months of the year. This figure exceeded that obtained from eight furnaces by the same companies during the high-pressure war years, and is due to technical improvements recently introduced, which have increased the yield by approximately one-third.

"The productive capacity of the twelve coke blast-furnaces which now exist in Italy therefore amounts to over 800,000 tons of pig iron a year, to which we must add the small but growing output of the electric furnaces. As Italy's pig iron requirements in 1925, a busy year, amounted to approximately 750,000 tons, it is evident that the home industry is equal to meeting the demand. It is, however, estimated that the national supplies of ore and pyrite ash are at present only adequate to meet 65 per cent. of those required to produce all the pig iron which Italy consumes."

A Sixty-Atmosphere Steam Plant.

In a recent issue of the *Borsig-Zeitung*, the technical house journal published by A. Borsig G.m.b.H., of Berlin-Tegel, an account is given of some tests carried out by Professor E. Josse, of Charlottenburg, of a high-pressure engine and boiler plant built for a working pressure of 60 atmospheres, which has now been in successful operation at the firm's Tegel works for a period of over eighteen months. Work was began on this installation as early as 1921, in collaboration with the Schmidtschen Heissdampf Gesellschaft, of Kassel-Wilhelmshöhe, but progress was delayed owing to the difficult economic and industrial position brought about by the French occupation of the Ruhr district, which delayed the delivery of the high-pressure boiler drums. However, the plant was completed and set to work in January, 1925. It has since been described in the *V.D.I. Journal* and also in the *Elektro Journal* of December 25th last, from both of which some of the particulars given in what follows have been taken.

In the main the plant comprises a 60 atmosphere water-tube steam boiler and a compressed high-pressure tandem steam engine. The general arrangement of the plant is illustrated diagrammatically in Fig. 1, which shows the high-pressure, medium, and low-pressure steam mains and the various services for which the steam is employed in its fall from a pressure of 60 atmospheres to 0·5 atmospheres or vacuum.

The engine, which is shown in Fig. 3 and will be referred to later, is used to drive an air compressor, which delivers air to the works at a pressure of 7 atmospheres. The engine receives its steam at a pressure of 60 atmospheres, and it exhausts at 11 to 13 atmospheres into a receiver, to which is coupled a boiler arranged to utilise the waste heat from a furnace. The steam passes thence to a hammer—previously worked by live steam at a reduced pressure—and a steam-hydraulic forging press, which are connected to the medium-pressure main. The exhaust from these machines, supplemented by steam at a pressure of 0·5 to 1 atmosphere from the back or low-pressure portion of the boiler which we are about to describe, then passes *viâ* a Rateau accumulator either to a low-pressure turbine and a condensing plant or to a low-pressure heating plant. In the summer the turbine and condenser are used, while in winter the low-pressure steam is employed for workshop heating. The amount of available heat

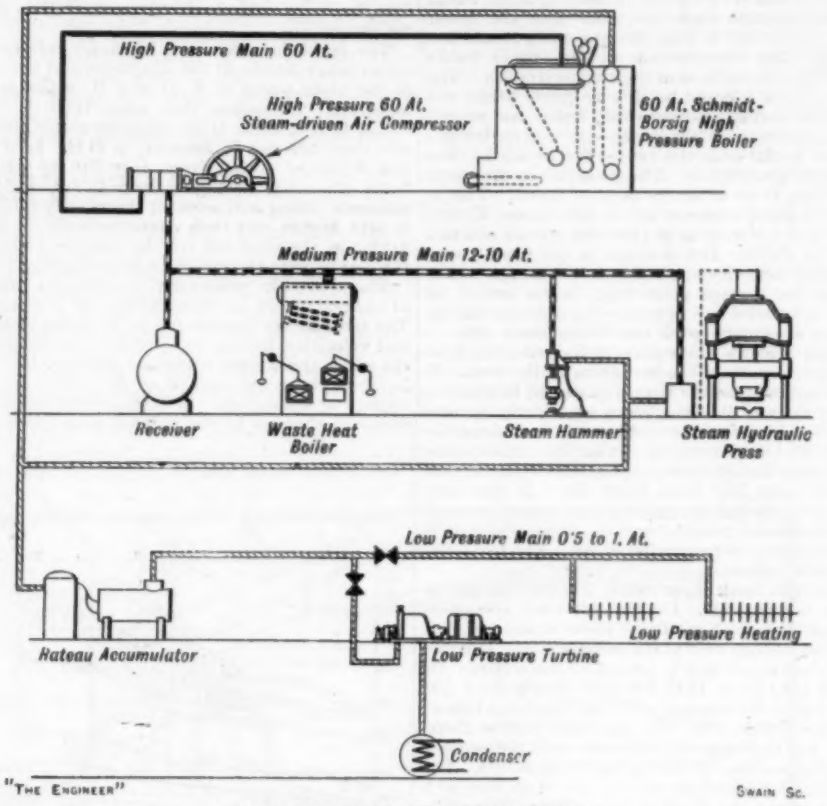


FIG. 1—DIAGRAM OF STEAM DISTRIBUTION

utilised in each case is as follows, the figures given being expressed as a percentage of the available heat :—

	Summer. Per cent.	Winter. Per cent.
Heat delivered as work	29	20·5
For heating workshop	0	77
Loss by radiation, condensate cooling and in condenser	71	2·5

We show in Fig. 2 two sectional elevations of the Borsig-Schmidt boiler. The high-pressure boiler proper possesses two banks of tubes, one inclined and one vertical, each connected to an upper and a lower drum, as well as to a steam drum arranged above. These two banks of tubes are those to the left and in the centre in the engraving. Between the two banks of tubes is fitted a two-part superheater. Beyond the second bank of tubes, in the fifth pass of the gases, is a low-pressure boiler, which raises steam at about 2 atmospheres pressure, for the low-pressure turbine and heating system, as already mentioned. This low-pressure steam is also used to heat the feed water of the high-pressure boiler to a temperature of about 100 deg. Cent. The high-pressure steam drums, five in number, which are all forged from the solid, with closed-in ends, were manufactured by Fried. Krupp, of Essen. The drums have an outside diameter of 400 mm. and an approximate length of 4000 mm. The principal overall dimensions of the boiler are given in the drawing, Fig. 2. The temperature of the superheated steam is 425 deg. Cent., and the boiler has a total evaporating surface of about 280 square metres, with a rated capacity of 7000 kilos. of steam per hour. The water capacity is 12,225 kilos., and the superheater has a heating surface of 134 square metres, whilst the grate area of the boiler is 10·2 square metres.

Referring to Fig. 2, it will be observed that the front upper drum, seen to the left in the drawing, is protected from the direct heat of the flue gases by a cast iron plate, which passes across the bank of tubes and provides an air passage underneath the drum, which enables the ends of the tubes to be inspected whilst the boiler is at work. The Borsig design allows the water content of the boiler to be very large, nearly double that of the hourly rated capacity of the boiler. Later investigations have, we understand, gone to show that the water capacity might safely be reduced, and the elasticity of the installation increased by the use of accumulators.

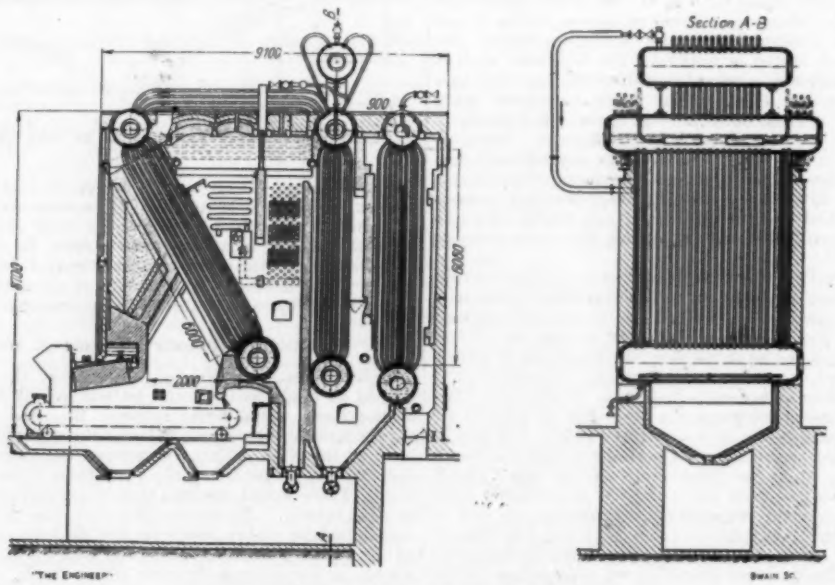


FIG. 2—BORSIG-SCHMIDT HIGH PRESSURE BOILER

Originally it was intended that both lower drums should be connected together by tubes, so that one closed circuit would be given for the water in the boiler. Experience showed, however, that these connecting tubes were not required, and in the boiler as constructed there is circulation in each bank of tubes. With this arrangement it follows that the hot mixture of steam and water rises high in the boiling tubes, and water streams back to the lower drum through downcomer tubes. It may be remarked that the second bank of tubes plays in this arrangement a comparatively unimportant part in the steam raising, but it does play a large part in increasing the water content of the boiler. The tubes have diameters of 60/52 mm.,

and they are rolled into the holes in the drums, the ends being beaded over.

With a steam output of 7000 kilos. per hour the rate of evaporation—in view of the area of evaporating surface of 280 square metres—is quite small, namely, about 25 kilos. per square metre of evaporating surface per hour. In practice it has been shown that greater outputs, up to 34 kilos. to 38 kilos. per square metre, can be obtained. The superheater elements are arranged in two parallel flows, and their duty can be regulated by a damper.

The Schmidt-Borsig boiler was put to work in October, 1924, and no trouble has, so we gather, been experienced, although it has been in constant use since that date. In March, 1925, Professor Josse conducted his test of the plant, and obtained the following results :—Hourly evaporation, 9180 kilos.; hourly evaporation per square metre, 30·57 kilos.; boiler pressure, 59·6 atmospheres; CO_2 percentage, 13·07; overall efficiency of boiler superheater and feed heater, 85·6 per cent.

Brief reference may finally be made to the high-pressure Borsig-Schmidt steam engine, which is illustrated in Fig. 3. It is designed for an output of 760 horse-power at a normal speed of from 90 to 120 revolutions per minute, when supplied with 60-atmosphere steam and working at a back pressure of 10 atmospheres. The tandem arrangement of the cylinders with gear of the Hochwaldt balanced piston

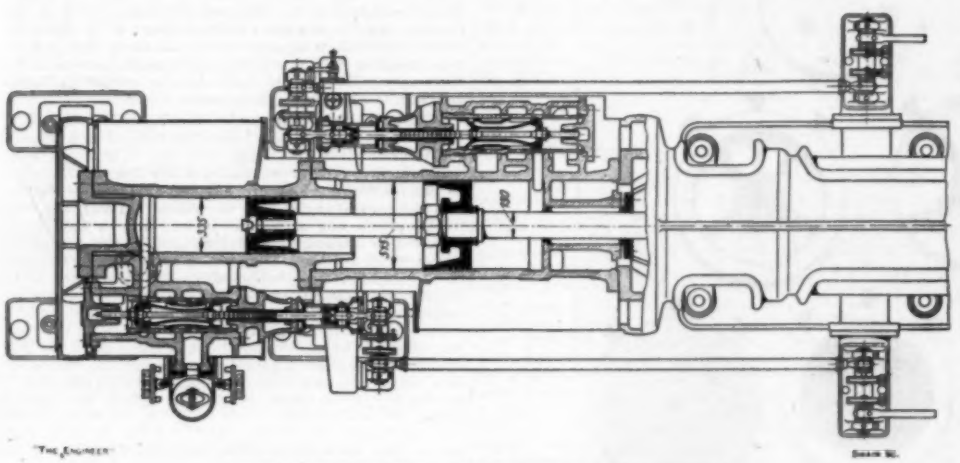


FIG. 3—BORSIG-SMIDTZ HIGH PRESSURE STEAM ENGINE

valve type will be observed in the drawing. The high-pressure cylinder has a diameter of 335 mm. and the low-pressure cylinder of 515 mm., with a common stroke of 900 mm.

During Professor Josse's trials the engine was run at a speed of 116·5 revolutions per minute, with a total output of 409 indicated horse-power in the high-pressure cylinder and 435 in the low-pressure cylinder, or a total of 844 indicated horse-power, with a measured steam consumption of 7·59 kilos. per indicated horse-power hour.

Repairs Afloat.

ALL engineers deplore the gradual disappearance of the old-time millwright, who could turn his hand to almost every form of handicraft and could repair the most formidable breakdowns with the most unpromising materials, and although no one will deny that their profession is practically extinct, we have just found, almost simultaneously, from opposite sides of the world, examples that show the art to be still alive in the minds of some modern engineers.

These two examples deal, in the one case, with the failure and repair of a steam turbine on board of one of H.M. repair ships, attached to a flotilla of destroyers, and is described in the Second Prize Marrack Essay, in the *Naval Engineering Review*, by Mr. R. Stallion, E.R.A.; while the other concerns an air pump breakdown on board an Australian vessel, of which an account is given in the *Commonwealth Engineer*.

Taking first the turbine mishap. The machine in question was one of two on which the workshops of the repair ship relied for their motive power. It was of normal design and of the five-stage Curtis combined impulse type. It ran at 3000 revolutions per minute, and was directly coupled, through a flexible coupling, to an electric generator. At the forward end of the rotor spindle there was attached a short length of shaft having six collars to take up the end thrust.

The trouble with the turbine was that it would not take full load without this thrust warming up seriously, while the speed dropped from 3000 to 1000 revolutions per minute, when the load was increased from 600 to 800 ampères. The turbine casing was opened up, and it was found that the first row of blading was damaged by a V-shaped groove about $^3/_{16}$in. deep on the entry side of each blade. As the blading could not be renewed, it was decided to concentrate attention on the thrust block. The collars were trimmed up in the lathe, a new thrust fitted and several alternative lubricating systems tried, but the thrust wore away $^1/_{16}$in. in a very short time, and altogether twenty-four new thrust blocks were made and fitted, when the stand-by turbine gave out from the same cause. To add to the troubles of the staff, the temperature in the engine-room was 110 deg. Fah. The second turbine was, however, nursed into carrying enough load to keep one or two machines in the shop running, and then a new scheme was tried with the first set.

The thrust shaft was put in the lathe and all the collars turned off. It was threaded and a thin sleeve was made to screw on this thread. The sleeve had a flange at the centre of the same diameter as the original thrust collars. Two ball races belonging to a motor pump were appropriated, and their bore ground out to suit the outside diameter of the sleeve. These two ball thrusts were arranged one on either side of the central flange. A gun-metal box or housing was cast for the ball races and machined to fit the main casing, while, as a precautionary measure, a plain flange was screwed on to the extreme end of the shaft, so that it would butt up against the end of the housing in the event of the balls failing, and prevent the complete wreckage of the machine.

When these repairs had been effected it was found that the turbine would comfortably carry full load, and the other machine was consequently altered in a similar manner. The two sets ran satisfactorily for nine months, but when they were overhauled and rebladed at the home dockyard and reinstated in the original fashion, they gave the same trouble again. Finally, the makeshift ball thrusts were put back again and so the machines remain.

In the case of the air pump accident, the crosshead stripped off its rods while the ship was proceeding down the Gulf of Aden—a place where the engine-room temperature ranges from 142 deg. to 154 deg. Fah.—and yet the ship was under full steam again within ten hours. The temporary repair was effected by clamping a spare set of winch brasses round the rod and bracing it up to the crosshead by two wide flanges and bolts long enough to make a clamp reaching from the underside of the brasses to the top of the crosshead. Some $\frac{3}{4}$in. pins were also screwed through the boss of the crosshead and countersunk into the rod.

Although this repair enabled the ship to proceed, the chief engineer, Mr. A. U. Cross, naturally wished to have a more substantial arrangement, and yet not delay the vessel in port while a new crosshead was being made. So he hit on the ingenious expedient of sending the necessary instructions to one of the repair shops in Colombo by wireless telegraphy. He made a sketch, in elevation and plan, of the piece required, and with it in front of him composed the following message :—

"Due noon Monday require steel crosshead for air pump forged solid consisting of centre rectangular block having on each side tapered piece terminating in journal pin for link brasses end of pin having collar stop front elevation overall length sixteen one eighth rectangular centre three seven eighths long seven deep stop tapered piece maximum diameter three eleven sixteenths minimum diameter two seven eighths length two thirteen sixteenths stop journal diameter two and quarter fillets quarter radius length including fillets three stop collar diameter two seven eighths thickness five sixteenths stop plan rectangular centre three seven eighths long three seven eighths wide other sizes as for elevation stop diameter of hole for rods one three quarter hole continuous top to bottom stop all sizes in inches stop final instructions on arrival."

When the ship reached Colombo the new crosshead was in the lathe only waiting to be screwed, and the ship left again the same night with the new crosshead permanently in position. This achievement, as the *Commonwealth Engineer* observes, reflects great credit upon the repair shop for its intelligent interpretation of the wireless message and its prompt execution thereof. The only flaw in an otherwise perfect phrasing occurs in the last few lines, where the plural word "rods" occurring shortly after the singular word "hole" was misleading, and as it was a detail that could be finished off in a comparatively short time, the centre was therefore left solid, but otherwise completed and in the lathe already to be bored and screwed as mentioned. As an additional safeguard a couple of pinching bolts were put in at the ends for each rod, which was certainly of great assistance in the event of either or both threads being distorted by the original stripping or subsequent usage.

South African Engineering Notes.

The Kalahari Lakes.

In the report of the "Kalahari Reconnaissance of 1925," just published by the Union Government, much cold water is thrown upon the scheme of Professor Schwarz for the restoration of the lost lakes of the Kalahari, which has been referred to several times in these notes.

The problem which the Government survey party set out to investigate was the contention of Professor Schwarz that not so long ago the Etosha, Ngami and Makarikari Lakes in the Northern Kalahari were larger as well as permanent, but that the gradual deepening of the bed of the Cunene in the west and of the Linyanti and Zambesi in the east has progressively been draining this flat central region. The Professor argued that if these lakes were to be restored artifically by suitably placed diversion weirs across the Cunene and the Linyanti, the evaporation from the additionally impounded waters would, by rendering the atmosphere appreciably more humid, help to bring about the condensation of water vapour in the air, and its precipitation not only over the immediate neighbourhood, but ultimately over a vastly wider area; in fact, even over much of the Union hundreds of miles to the south. At the same time, so far as the idea can be understood, it was that the overflow from the Okavango and Linyanti Lakes could be led across the central Kalagari and utilised for irrigating that wide and semi-arid region, so that a huge area would thereupon become available for closer settlement.

The report proceeds to analyse the various schemes from the geological and economical standpoints, and among the conclusions arrived at are :—(1) That the idea of a former greater rainfall in the Ngami-Makarikari region in the historic period is based upon a misinterpretation of the facts of the historic records, and that the climatic conditions do not appear to have altered appreciably within the limited period with which we are particularly concerned; (2) the facts do not favour Professor Schwarz's conception of an ancient "Greater Ngami," and that the latter cannot therefore be restored; (3) owing to the immense losses through evaporation and absorption within the Okavango delta and the Linyanti swamp, no extensive scheme of flooding either the Ngami or the Makarikari region is possible without including the bulk of the Zambesi flow. Canalisation of the Okavango through the delta, it is pointed out, would doubtless provide water for the Makarikari region, but unless it were used for the purpose of irrigation, it would merely be draining one swamp to produce another elsewhere.

The report then goes on to consider the question of damming the Zambesi at Katombora to a height of just over 60ft., and thereby forming two lakes having a combined area of about 4600 square miles, and states that it would seem practicable to irrigate an area of about 125,000 acres within the Mabobe depression with water drawn from the Linyanti River by simple diversion *viâ* the Savuti Channel at a cost of approximately £5 per acre, including distribution. It would furthermore be possible to irrigate the eastern part of the floor of Lake Ngami to the extent of some 30,000 or 40,000 acres with water from the Okavango system alone, in one or two ways at a cost of just under £100,000, or approximately £3 per acre, excluding distributaries, or perhaps £6 including distribution.

It does not fall within the scope of a reconnaissance of this character, states the report, to point out all the various problems and difficulties that would arise under the adoption of any one of the schemes put forward. These would more thoroughly be appreciated and handled by the Governments directly concerned. The report states, in conclusion, that while the ambitious ideas of Professor Schwarz are not likely to be realised in practice, it is not improbable that in the future one of these schemes of irrigation will enable a portion of this waste space in Southern Africa to be satisfactorily settled.

Witbank Colliery on Fire.

The Witbank Colliery in Rhodesia had been on fire for a fortnight at the end of July, at which time it was the scene of extraordinary activity. The principal point of concentration at the time this note left Cape Town was near the incline shaft, about a mile from Witbank, where the fire had been located and isolated by strong brickwork underground. Six shot drill machines were at work, and fourteen boreholes had been completed. Many of them were being actively sand filled. Through the holes sludge, a mixture of sand and water, was being steadily poured for the purpose of choking the fire.

Increased Rail Traffic.

The number of passengers carried on the suburban lines of the Union of South Africa during the financial year ended March 31st, 1926, totalled 63,847,984, an increase compared with the previous year of 4,655,577. Passengers to the number of 76,282,587 were carried on all lines during the period April 1st, 1925, to March 31st, 1926, constituting a record and representing an increase of 5,450,398 over the preceding twelve months, when the previous record was established.

During the year ended March 31st, 1926, the weight of goods—other than coal—conveyed totalled 11,373,643 tons. No greater tonnage has been moved in any one year on the Union railways. In comparison with the year ended March 31st, 1925, the figure represents an increase of 2,319,240 tons. The items which contributed principally to the improvement were :—Maize, 1,466,148 tons, an increase of 855,522 tons; sugar cane, 1,238,683 tons, an increase of 523,498 tons; flour, meat and bran, 612,178 tons, increase 134,239 tons; sugar, 358,959 tons, increase 122,136 tons; timber (rough), 654,952 tons, increase 92,121 tons; manures and fertilisers, 321,079 tons, increase 79,850 tons; bricks and building stone, 478,063 tons, increase 77,308 tons; ores (for export), 124,828 tons, increase 64,779 tons; general merchandise, 1,256,893 tons, increase 59,746 tons; fruit, fresh and dried, 175,949 tons, increase 42,628 tons.

Pig Iron Production.

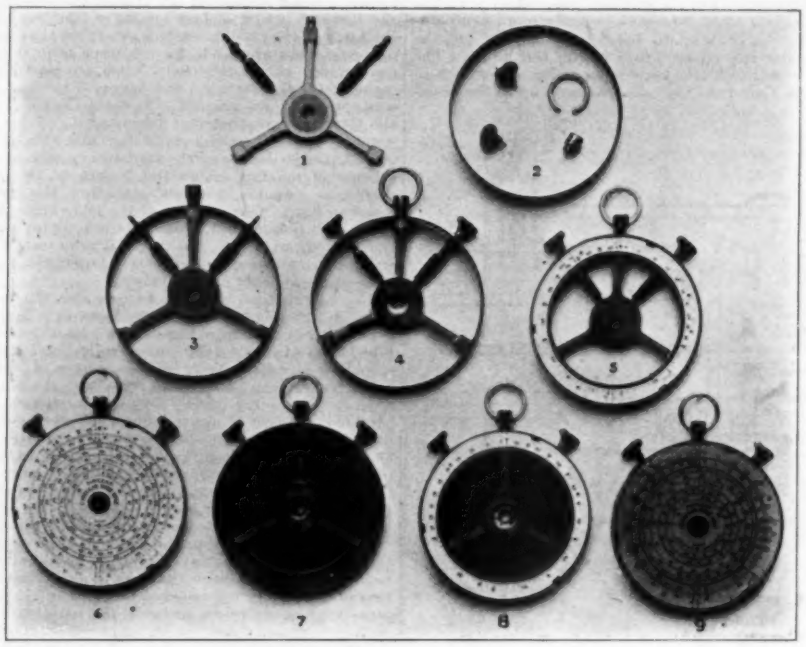
Since the first "tapping" of the blast-furnace at Newcastle, Natal, pig iron production has continued fairly smoothly, though there have been minor difficulties, and a few "gassing" incidents have occurred, which have been due to the inexperience of the labour available. It is stated that the quality of the pig iron produced is quite up to expectations. The whole output is at present being sent by rail to the Vereeniging steel works, in the Transvaal, where it is undergoing various tests, so that when it is available for sale other ironworkers will have the benefit of the results of the test applied.

A LARGE soap factory is to be put up at North Wall, Dublin, by Lever Brothers.

A New Circular Slide Rule.

After many years of patient endeavour, Mr. William H. Fowler, M. Inst. C.E., M.I. Mech. E., assisted by his son, Mr. Harold Fowler, A.M.I. Mech. E., Station Works, Sale, near Manchester, has succeeded in placing on the market a neat and handy calculator or slide rule in circular form, which is the best of the kind we have seen. At first sight it would appear that the production of such an instrument was not an extraordinary achievement, but Mr. Fowler was not satisfied with the average degree of accuracy; his object was to produce something, the accuracy of which should be unimpeachable, and at a price within the capacity of every likely user.

To be really successful, a circular instrument must equal in utility a 10in. straight rule. The scales must be



FOWLER'S CIRCULAR SLIDE RULE CALCULATOR

marked with extreme accuracy and furnished with a radial cursor line, and also—depending on the type of instrument—with a fixed radial datum line. The scales and the cursor must each be capable of independent rotation without any possibility of one movement affecting the other. Further, the movements must be "dead-beat," *i.e.*, without back-lash. In addition, the radial lines on the scales, the cursor line, and the datum line—if there is one—must rotate with precision round a common axis. Superimposed on the above conditions is the necessity for the scale, the cursor and the datum line being as close together as possible to avoid parallax in reading.

At a recent visit we paid to the works we had a full opportunity of inspecting the methods and tools by which the instruments are made, and were much impressed with the ingenuity that has been brought to bear on the design of the instrument, as well as on the tools for its manufacture to secure the very accurate repetition work necessary to permit of production on commercial lines. At an early stage it was found that satisfactory progress was impossible until the complete manufacture of every detail was undertaken and, simple as some of the parts appear, the construction of the necessary jigs and press tools entailed much time and expense.

There are two ways in which addition or subtraction, as practised with a straight slide rule, can be effected when the scales are arranged in circular form. Both ways are adopted in the instruments made by the firm, and constitute two different types. In one, designated the "slide-rule" type—shown above—the scale or scales are marked on an outer fixed annulus and corresponding scales radially opposite are marked on a rotating dial inside the annulus. The zero line on the fixed annulus serves as a datum, and, combined with the radial cursor line, permits of the results of any calculation made with the instrument being read. This type is a close imitation of the principle of the straight slide rule, and is often preferred by those who have been accumstomed to the use of that instrument.

With the straight slide rule most users work with the half length scales to insure the result of any given multiplication or division being visible without any shifting of the slide, whatever the factors may be.

With the circular slide, the scale is, of course, continuous because there cannot be any drawing out of the slide, or need for shifting, and the setting is effected whichever way the dial is rotated. Viewed in this way the circular slide, Messrs. Fowler claim, is equivalent for accuracy of reading results to a straight slide rule of double the length of the circumference, and as this is 6·7in., it is equal to a straight slide rule 13·4in. long.

In the other type, designated the long-scale type, there is no fixed annulus, but only a rotating dial on which all the scales are marked. In addition to the radial rotating cursor, however, there is a radial fixed datum line marked on the glass of the instrument. This arrangement possesses special advantages. It allows, for instance, of the use of a multiplying and dividing scale extending over several circles, in addition to the one on a single circle; and so permits of great accuracy in reading results. Thus in the instrument made by the firm, which is only 2¾in. in diameter, the long scale has a total perimeter of 30in. in length and therefore, as explained, for comparative reading purposes, is the equivalent of a straight slide 5ft. in length. This scale is undoubtedly a great advantage, and is much appreciated by engineers and scientific workers who occasionally desire to read results with great accuracy.

The choice of type of instrument is a matter for the user to decide by his particular requirements. The same problems can be worked on both.

To meet the special needs of different trades and professions, the firm makes a variety of scales. In the textile industry, weights, areas and costs of cloth in English and metrical equivalents are often required. Surveyors and artillerymen are more concerned with questions of trigonometry, range finding, &c. Engineers and students desire a more general grasp of calculations, including powers, roots and conversions from English to metric units, and *vice versâ*.

The mechanical construction of the instruments will be readily followed from a reference to the accompanying views of the details. The instrument consists of an outer cylindrical ring holding within it a three-armed "spider" with a central boss in which a ferrule is fixed. The outside diameter of this ferrule forms the bearing of the wheel which carries the front dial, and which is operated through the medium of a radial shaft and milled thumb-nut outside the case. Inside the fixed furrule rotates a central stud carrying at the front end the transparent disc on which the radial cursor line is marked. This stud is driven from the other end by a wheel, on which the back dial is mounted, and, like the front wheel, is operated through the medium of a radial shaft and milled thumb nut outside the case.

The ring forming the cylindrical part of the case is by itself slightly flexible, and so permits of the three-arm "spider" and the two radial spindles being easily assembled. But when the two circular glasses, on which the radial datum lines are marked, and which rest on the rims of the cylindrical piece, are fixed in position by their respective containing bezels, which are an exact sliding fit on the cylindrical piece, the whole becomes a perfectly rigid structure that permits of its separate parts being easily replaced if accidentally broken or deranged. Spare glasses fitted in their respective bezels can be supplied, if desired, so that the user can himself fit a new glass. This is an advantage to a purchaser in an inaccessible place abroad or to an artillery officer on service.

The complete instrument measures 2¾in. diameter by $^{7}/_{16}$in. thick. The advantages claimed for the instrument by the makers over the ordinary 10in. straight rule are that it is more portable, it gives extremely accurate results it is more easily and quickly operated, there are no sticking or loose slides, it is independent of climatic conditions, and the scales are always clean and easy to read.

Scholarships for Science.

Royal Scholarships and Free Studentships.—The Board of Education offers annually a number of Royal Scholarships and Free Studentships tenable at the Imperial College of Science and Technology, London. The awards are determined on the results of the Science Scholarships Examination, which is held by the Board each year in the spring. They are open to British subjects of either sex and there is at present no age limit. A Royal Scholarship or a Free Studentship entitles the holder to payment by the Board of the fees for admission to the lectures and laboratory and other work appropriate to the approved course. Royal scholars will also, subject to evidence of financial need, be paid a maintenance allowance not exceeding £80 a year. Full details of the examination for 1927 are published in the "Syllabus of the Science Scholarships Examination, 1927," which may be obtained, price 4d. (by post 4½d.) through any bookseller or direct from H.M. Stationery Office at the following addresses:—Adastral House, Kingsway, London, W.C. 2; 28, Abingdon-street, London, S.W.1; York-street, Manchester; 1, St. Andrew's-crescent, Cardiff; and 120, George-street, Edinburgh.

Whitworth Scholarships for Mechanical Science.—The Board of Education also offers for competition annually six Whitworth Scholarships and two Whitworth Senior Scholarships on the Foundation of Sir Joseph Whitworth, to candidates possessing handicraft experience obtained in a mechanical engineering workshop. In addition, Whitworth prizes not exceeding twenty-five in number are awarded to unsuccessful competitors for the scholarships whose work appears to deserve recognition. Full details of the value of these scholarships, &c., the limits of age, conditions of award, and subjects of competition are published in the "Regulations for Whitworth Scholarships, 1925," which will remain in force for 1927, with the exception that the maximum age limit of candidates for Whitworth Scholarships is raised from twenty-one to twenty-two years. These regulations may be obtained, price 2d. (by post 2½d.) at H.M. Stationery Offices, as indicated above.

14-Seater All-Metal Omnibus.

The accompanying illustration represents an omnibus which has recently been completed by Short Brothers, Ltd., of Rochester.

Messrs. Short Brothers have had extensive experience in the design and construction of all-metal aeroplanes and flying boats, being, we believe, the pioneers of that method of construction, and as large vehicle body manufacturers and designers, they thought that the use of light alloys in the place of steel would not only retain the advantages of steel construction, but would also have the added important advantage of economical weight. In the construction of the 14-seater metal body shown in the engraving, the aim of the designers was, therefore, to obtain a light body consistent with strength and rigidity. To meet those requirements, a structure of built-up light alloy members was designed and patented. The method of construction

OMNIBUS WITH BODY OF LIGHT-ALLOY MEMBERS

is, we gather, practical in that no expensive dies are required, and it can be adapted to any size of commercial or passenger-carrying vehicle to comply with the Ministry of Transport regulations. One of the advantages of metal-constructed bodies is that they are not affected by weather conditions and cannot warp, so that they retain their appearance.

The omnibus is one of a fleet of six built for the Maidstone and District Motor Services, Ltd., the remaining five being of wooden construction. It is worthy of note that whereas the all-metal body with seats weighs 9 cwt., the corresponding wooden one with seats weighs 15 cwt., a saving in weight of 40 per cent. Thus the metal body will carry four more passengers for the same running cost.

Besides giving more economical running cost, it is estimated that this type will have much longer life because of the decrease in self-made stress, due to less structure weight, and the elimination of weak joints found in wooden construction. Tests carried out are said to show that this body does not "drum" so much as one of wooden construction, and is quieter, owing to it being so rigid. We may add that the chassis is a 30-cwt. Guy.

BRITISH STANDARD SPECIFICATION FOR PORTLAND BLAST-FURNACE CEMENT.

THE British Engineering Standards Association has now published a new issue of the British standard specification for Portland blast-furnace cement (No. 146—1926), which was first issued in 1923. The modifications follow precisely the same lines as those introduced into the current issue of the B.S. specification for Portland cement issued in 1925—Report No. 12—the following being the principal alterations embodied in the 1926 edition of Report No. 146: —(1) A summary of the tests is given at the beginning of the specification: (2) provision has been made for testing in hot countries at temperatures up to 95 deg. Fah. In climates in which the temperature runs above 95 deg. or below 58 deg. special arrangements have to be made between the vendor and the purchaser unless the ranges given in the specification can be artificially produced; (3) the cement is now required to be more finely ground, the permissible residue on a 180 × 180 sieve being 10 per cent. instead of 14 per cent.; tolerances are laid down for the number and size of wires and size of openings in sieves, both for cement and for sand; the minimum size of the sieving area is now specified to be 50 square inches and the minimum depth of the sieves to be 2½in.; (4) the maximum figure for the hydraulic modulus of the Portland cement clinker has been raised to 2·90 and the maximum limit for magnesia is now 4 per cent.; (5) the minimum tensile breaking strength of neat cement after seven days has been increased to 600 lb. per square inch, and that of cement and sand after seven days to 325 lb. per square inch; the twenty-eight-day test on neat cement has been eliminated; (6) the amount of water for gauging cement and sand briquettes is now to be ascertained by means of a formula based upon the amount needed to produce the plastic mixture required in the tensile test for neat cement; (7) the standard Leighton Buzzard sand is required to be of the white variety, and its loss of weight on extraction with hot hydrochloric acid is specified not to exceed 0·25 per cent.; and (8) the initial setting time of normal setting cement is to be not less than thirty minutes and the initial setting time of quick-setting cement not less than five minutes. Copies of this publication (No. 146—1926) can be obtained from the B.E.S.A. publications department, 28, Victoria-street, London, S.W., price 1s. 2d. post free.

CONTRACTS.

THE firm of Avions Michel Wibault, of Billancourt, Paris, has received an order for its all-metal monoplanes from the French Government. The machines are similar to those being built by Messrs. Vickers at Weybridge for a foreign Government.

THE METROPOLITAN VICKERS ELECTRICAL COMPANY, Ltd., in addition to the 41 electric freight locomotives, which it is building for the Great Indian Peninsula Railway has also received from that line an order for a high-speed electric passenger locomotive, which will possess many very interesting features. It will be the 4–6–2 engine, and will comprise three driving axles, one four-wheel bogie truck, and one two-wheel pony axle working in conjunction with the nearest driving axle, so as virtually to form a four-wheel truck. It will be used for high-speed service, and is to be mechanically safe up to a speed of 85 miles per hour. It will be fitted with six 360 horse-power motors, and provided with the Metro-Vick standard electro-pneumatic control.

THE ENGLISH ELECTRIC COMPANY, Ltd., of Queen's House, Kingsway, London, W.C. 2, has received an order from the High Commissioner for the Government of India for electrical equipments for the Great Indian Peninsula Railway—Kalyan extension. The order comprises fifteen motor coach and forty-two trailer coach equipments, and is a repeat of a previous order, which included equipments for thirty-eight motor coaches and control equipment for one hundred and eleven trailer coaches. The High Commissioner has placed a further order with the company for twelve 750-volt rotary converters to be coupled in series for 1500 volts. Each will be 1250 kilowatts, or 2500 kilowatts for each pair, and, in addition, the company is supplying 22,000-volt transformers and automatic direct-current switchgear for three complete units.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE STEAM FITTINGS COMPANY, Ltd., of West Drayton, Middlesex, announces that its name has been changed to the Drayton Regulator and Instrument Company, Ltd. This change does not imply any change of directorate or other reorganisation, but has been decided upon because it was considered that the old name was no longer truly indicative of the nature of the company's manufactures and specialties.

THE ROYAL METAL TRADES PENSION AND BENEVOLENT SOCIETY.—The seventy-eighth anniversary Festival Banquet of the Royal Metal Trades Pension and Benevolent Society, which was postponed from June 1st, has now been fixed for Tuesday, November 2nd. The consent of the Prince of Wales to attend on this date has been received, and the Lord Mayor of London, Sir William Robert Pryke, will preside. It is announced that the Board of the Society has come to the decision that on this special occasion the Festival shall be open to ladies.

VISIT TO THE CREWE WORKS.—By permission of Sir Henry Fowler, K.B.E., chief mechanical engineer of the London, Midland and Scottish Railway, between thirty and forty members of the Manchester Centre of the Institution of Locomotive Engineers and their friends visited the Crewe locomotive works on July 22nd, 1926. The party was conducted round the works by Captain H. P. M. Beames, mechanical engineer, and Mr. Lemon, works manager, and other members of the staff, and at the conclusion of the visit was invited to tea by Captain Beames. A hearty vote of thanks, proposed by Mr. J. H. Haigh, member of the Committee, seconded by Mr. F. S. Barnes, member, was accorded to Sir Henry Fowler, Captain Beames, Mr. Lemon and members of the staff for the most interesting visit and for the hospitality afforded them.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

THE heavy industries of the Midlands and Staffordshire have been slow to resume after the holiday break, and there is a disposition in certain quarters to remain closed until the coal deadlock is settled. Only a few Black Country mills have resumed production and that on quite a limited scale. The coal that has been available for some time is unsuitable for the making of iron, and attention for the time being is devoted mainly to the steel branches. A development welcome to many engineers in the district is the restarting of several forges in the Dudley area, now able to utilise the increasing quantities of coal produced by the Cannock and Warwickshire pits. The firms in question have very good order books, and look forward to a period of activity, probably for the rest of the year. Higher prices have to be charged to cover the additional cost of coal, but they are readily paid by the consumers, many of whom are in great difficulties for lack of high-quality iron. Engineers have made a partial resumption this week, but business is spasmodic. Buying of iron and steel materials is restricted to immediate requirements, and values are, to a great extent, ruled by individual circumstances. The attendance at the weekly meeting of the Midland iron trade to-day—Thursday—though showing improvement on that of last week was considerably below normal.

Steel Business.

Midland engineers are making every effort to utilise the odd sizes stocked and listed by large steelmaking concerns. These sizes in ordinary times would not be entertained, but the desire for British steel is so great that quantities of most unusual sizes have, in many instances, been disposed of within a few days of the offers being received. It is still possible to buy some classes of structural steel from stock, but a premium of £1 10s. to £2 on the recognised basis is generally required. A large mill has been restarted for the production of rounds, squares and flats, and another concern hopes to make a start this week on sections, with the view of preventing, as far as possible, more trade being diverted from this country to continental rivals. A tremendous amount of business has already been lost in this way. The steel works have good order books, but new business has fallen off lately, owing to the serious risk involved in giving or accepting tenders in connection with which the bulk of the material required consists of finished steel. Engineers, builders, and others having big contracts to place prefer to await the reopening of the works before inviting tenders. To some extent the same policy is adopted by steel makers, who want to be on much safer ground before quoting for future steel deliveries. All continental steels are dearer when reasonably early delivery is required. Cheap steels are still on offer; but they are practically useless when, as frequently happens, delivery cannot be given within three or four months. It is hoped that by that time some British steel will be available. Semi-finished steel is scarce, billets being quoted at £5 15s. to £6, and bars £6 to £6 5s. Deliveries are falling further into arrear, but most users having any prospect of re-rolling the material bought heavily several weeks ago.

Pig Iron.

Midland blast-furnaces remain idle. Supplies of native pig iron are cut off, and users in the Midlands continue dependent upon such supplies as they can obtain from the Cleveland district. Prices range from £5 5s. to £5 6s. 6d. Consumers state that that price does not warrant the placing of forward business, even if it could be done. Manufacturers cannot see far ahead, nor speak with any assurance of what prices are likely to be after the collieries are reopened. The influx of foreign pig iron has checked the upward tendency in values, and no attempt has apparently been made to increase the price of Middlesbrough brands. West Coast high-class steelmaking iron has only slightly advanced since the strike on account of the poor demand.

Foreign Pig Iron.

The first shipload of foreign pig iron has been delivered in the Birmingham district, and a good proportion has been distributed in the South Staffordshire area. The supply has been welcome at many foundries, where supplies of pig iron were scarce. It is believed that the quality will be found suitable for local engineering requirements, and the delivery will possibly prevent the stoppage of important works. Further, its advent will, it is hoped, have a steadying effect on Cleveland and Scotch prices, which have lately shown a decided upward tendency. Where necessary, British hematite will be added to raise the quality, and that material is still available in fair quantities.

Staffordshire Bar Iron.

There is no Staffordshire bar iron to be had, and consumers fight shy of Lancashire makes on account of the heavy price asked. There is little business being transacted, though quite good orders have been placed for supplies on the termination of the strike. Darlaston nut and bolt works continue in operation, and large quantities of Belgian No. 3 iron continues to arrive in the district for their use. The latest quotation is about £4 17s. f.o.b. Antwerp, or round about £6 delivered in the Black Country. There is, however, considerable congestion at Antwerp, and deliveries are uncertain.

Sheets.

The sheet mills are making a fairly steady output with bars imported from Belgium at a delivered cost of £5 13s. 6d. to £5 15s. The price of 24-gauge corrugated sheets ranges from £17 to £17 10s., according to the size and conditions attached to each particular order. It is stated that about one-third of the sheet mill capacity is now employed. Such business as is passing in strong copper sheets is on the basis of £90. A cut would be made for the Eastern markets, in which competition with foreign producers is keen.

Tin-plates.

The restart of some Welsh steel works has supplied material for more tin-plate mills. The tin-plate trade is rather quiet, franc fluctuations having discouraged continental buying. Much business, however, is known to be in suspense. The American mills are congested with work, and have refused business from buyers usually dealing with British mills.

Scrap.

Hardly any business is being done in scrap, the idle steel furnaces being unable to take delivery. Steel turnings have slumped badly in price, and can be bought at £1 per ton as against £2 5s. before the strike. Still lower prices are accepted by firms having to get rid of this bulky material which congests the scrap yards and rapidly deteriorates.

Fuel.

Coke has become very scare, and as much as £3 10s. has been paid locally for fuel approximating more nearly to furnace coke than to foundry quality. The latter has become almost unobtainable. Works coal is a little more plentiful, but it is exceedingly dear and makes profitable production a difficult matter.

Rail Order.

The Union of South Africa Railways has, I understand, placed an order for three dining saloons, with the necessary staff and kitchen cars, with the Birmingham Railway Carriage and Wagon Company, Ltd., Smethwick.

Birmingham Works Operative.

Although for three and a-half months the basic industries of the Midlands have been, practically speaking, paralysed, and a definite return to settled conditions is not yet in sight, it is surprising how little Birmingham manufacturers in light engineering trades have been affected. Most of the big works are carrying on, and unemployment, strangely enough, continues steadily to decline. In no small measure that is attributable to the importation of foreign iron and steel, in a lesser degree to foreign coal, and to the fact that a certain amount of coal has been obtainable from outcrop workings and later from the coalfields of the surrounding districts.

Mining Situation.

The local coal mining situation continues to show improvement, each day seeing an added number of miners reporting for duty, and an increased tonnage of coal raised. Much of this fuel is now finding its way to local engineering works, enabling them to continue in operation. There are, at the time of writing, more than 5000 miners at work in the Cannock Chase coalfield, and although no figures are being published of the coal tonnage drawn in that area, including Pelsall, it can be definitely stated that during the past week a minimum of 11,000 tons has been taken from the pits and placed on the market. At least 5000 miners are daily descending the pits in the Warwickshire coalfield, while reports show that work is now proceeding at forty-six pits in Derbyshire and Nottinghamshire coalfields, where, apart from safety men, 3352 men have returned to work. This number excludes thousands working on outcrops. Work has been resumed at practically all the collieries in the West Midland area, most of the pits being at full swing on an eight-hour day. About 70 per cent. of the men are back, and it is expected that practically the whole of the men will have returned by the end of the week. The position in the Midland coalfields is, therefore, considered most satisfactory.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

THE possibility of an early end to the long-drawn-out dispute in the coal-mining industry has infused a little more heart into the markets here, although there is still a good deal of caution displayed. There seems, however, to be little doubt that a settlement will see a spell of activity, at least for several months, that has not been seen for some time. Quite a number of contracts that have been secured by Lancashire firms have been announced during the last few days, most of them in connection with rolling stock for overseas, and among the concerns to benefit are the Metropolitan-Vickers Electrical Company, Ltd., of Trafford Park, Manchester; Beyer, Peacock and Co., Gorton, Manchester; the Vulcan Foundry Company, Newton-le-Willows; Nasmyth, Wilson and Co., Patricroft, Manchester; and the English Electric Company, Preston. In addition, the London, Midland and Scottish Railway Company has decided to put in hand 100 new 2–6–0 superheated locomotives at the company's Horwich and Crewe works.

Non-ferrous Metals.

During the past week the tin and copper sections of the non-ferrous metals markets, which lately have attracted most attention, have suffered a setback, although in the case of the latter metal it has not been very serious. Tin, however, has virtually lost all that it had gained during the two previous weeks, and thus once again bears out the saying amongst the "wise heads" of the metal markets that there is many a slip 'twixt tin—and the £300 mark. After a period of depression in values, there was a recurrence

of steadiness at the close, but the net result of the week's operations has been a loss which almost wholly, as has been said, accounts for the ground gained during the previous two weeks. Once again, presumably, will begin the steady trek upwards, for there is no doubt a strong belief in the market in the statistical strength of the metal. To some extent in sympathy with tin, copper has also lost a little ground, although to a less degree. Here, again, however, the close showed a better tendency from the point of view of values, and with the American reports that the Copper Export Association is already, although unofficially, in operation, a steady tone in this section of the market may be looked for. Both lead and spelter have received sufficient attention during the week to enable them to maintain their positions.

Iron.

The most interesting feature of the iron market here this week has been a definite move towards fixing up business for forward delivery. This has been by no means general, however, although it is not unlikely that more and more producers of pig iron will now be compelled to follow the lead that has been given to them and take the risks that may be involved in the process of quoting more or less in the dark as far as costs of production at the furnaces are concerned in the future. There is no doubt that the risks are not inconsiderable, for up to the present we have no means of telling what coal and blast-furnace coke are going to cost, but those firms that have taken the initiative have not fixed their prices without making some attempt to cover themselves. Curiously enough, the basis price of 80s. per ton at the furnaces, corresponds to the figure which I mentioned in this column in connection with forward business some weeks ago, and it is not unlikely therefore that the reports which I then gave had some solid foundation. This 80s. per ton, which so far relates only to Derbyshire makes of No. 3 foundry iron and is confined to quite a small number of producers, is equivalent to approximately 90s. per ton delivered in the Manchester area. Offers of foundry iron for prompt delivery are restricted to Scottish at about 107s. 6d. per ton, Middlesbrough at slightly less than this figure, and West Coast hematite at about 98s. Lancashire Crown bars still attract little buying interest, and there is no change in prices.

Steel.

The steel market shows little change from last week, more particularly as regards the position of British makers. There is a little home-manufactured material being offered, but nothing like sufficient to affect the general situation, although there is talk this week of one or two additional rolling mills starting up within the next few days, but, of course, merely on a limited capacity. Naturally, makers under present conditions of extravagant coal prices and other high costs, are asking prices that are much in advance of the minimum quotations fixed by the Steel Makers' Association two months ago. The same applies to the limited outputs of those re-rolling mills that are at work. The position of the market for continental materials has been an interesting one, because of the reports of the negotiations between the European producers and the later reports of the failure to reach an agreement, but it cannot be said that the situation has undergone much actual alteration so far as this centre is concerned. Prices have certainly improved to the extent of about 2s. per ton all round, compared with those quoted here last week, but the fact remains that few firms can be found which are willing to take on any more business just yet. Those that are, are asking figures that are higher to the extent of up to 20s. per ton, more especially if buyers are anxious and willing to pay for the privilege of securing early delivery.

Scrap.

There is still very little actual business passing in scrap metals, although hopes are running high as to active sales when the coal stoppage comes to an end. With the exception of copper scrap, which is firmer, most other varieties are steady and unchanged. Cast aluminium scrap is quoted this week at about £82 per ton, brass rod turnings at £39 10s.; scrap zinc, £25 10s.; scrap lead, £31 10s.; braziery copper, £52; clean light copper, £57; heavy copper scrap, £62 10s.; best selected gunmetal, £53 10s.; and heavy yellow brass, £45 for sorted qualities delivered to users' works. The market for iron and steel scrap remains very dull, and quotations are purely nominal.

BARROW-IN-FURNESS.

Prospects.

There are better prospects for the hematite pig iron trade in this district than there have been for some time. Orders have been booked for a fair tonnage, delivery to commence at some future date, to be dictated by the date of restarting of furnaces. There is a feeling that once the coal difficulty is overcome there will be a better period of trade in iron than there had been for many months prior to the stoppage. At present the stocks held are very low, and no doubt they are all secured by those requiring iron. In the ore trade there is very little being done, and an improvement will come when the furnaces restart. A small amount has been sold to buyers outside the district.

Steel.

The steel departments are idle with the exception of the hoop works, but steel makers are not short of orders, and once the mills can get to work again there will be a long run for several months, and that run will probably be extended by orders which will come in later.

Foreign Coal.

Coal continues to arrive in Barrow from America and the Continent in large quantities. The importations from America are much heavier than those from Rotterdam, &c., and a fair proportion of the American coal is on account of the London, Midland and Scottish Railway, which is despatching it from Barrow to various centres on its line.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

THE production of open-hearth steel continues at a standstill, as, although foreign and outcrop coal is obtainable in good quantities, the high price prohibits its use in the large amounts which the furnaces require. For the same reason, the blast-furnaces are still idle. On the manipulative side of the steel industry, conditions vary. As already reported, stocks of steel are running low, and, although firms are continuing to carry on, they are doing so with increasing difficulty. Even where they are well employed, the high cost of fuel is in most cases causing loss. Some firms are able to state that they are running without financial sacrifice, and some are in the remarkably fortunate position of having lost no time since the strike began, but they are exceptions. The rolling mills are still obtaining supplies of steel sufficient to turn out a fair amount of work. At the same time, users are finding it necessary to use odd sizes of material, and the ingenuity displayed by the managerial staffs has won general admiration. Railway steel production has been much curtailed. The report that Samuel Fox and Co., of Stocksbridge, were about to restart their rolling mill last week was regarded as a welcome sign, but it now appears that operations were not on the scale that many people assumed. Part of the plant was operated in order to cog down some ingots that were in stock, but the rolling of rails has not been resumed.

Railway and Shipping Orders.

There are evidently prospects of a good deal of work in the railway departments as soon as conditions are once more favourable. Several orders have been announced this week which are of interest to Sheffield. The Leeds Forge Company, which is a part of Cammell Laird and Co., Ltd., has received good contracts for rolling stock supplies for the Indian railways. The company is to build sixty bogie rail and timber trucks for the North-Western Railway, 112 bogie low-sided and 30 bogie high-sided wagons for the Indian State Railways, 60 covered goods wagons and 10 timber trucks for the South Indian Railway, 10 covered and 20 high-sided goods wagons for the narrow-gauge lines of the Bengal-Nagpur Railway, and 60 low-sided wagons for the Jodhpur-Bikaner Railway; all the vehicles to be fitted with Sheffield-Twinberrow bogies. The Vulcan Foundry, Ltd., of Newton-le-Willows, in which Hadfields, Ltd., of Sheffield, have an interest, has received an order from the Crown Agents for the Colonies to construct two 2–6–2 tank superheater engines for the Tanganyika Railways. With regard to shipbuilding, a message from Athens last week stated that the Lloyd Hellenic Navigation Company, in which Sir Basil Zaharoff and other Greek capitalists are interested, had ordered from Vickers Ltd. eighteen vessels, of from 3000 to 6000 tons, for trade between Greece, Egypt, Italy and the Black Sea. A sum of £1,000,000 was mentioned in connection with the matter, but was referred to as "capital." The message was not very clear, and it has not yet been officially confirmed, Messrs. Vickers' offices, at both London and Barrow, stating that they have not heard of it; but, needless to say, Sheffield is hoping that the report will prove to be correct. The outlook for shipbuilding at the other centres with which Sheffield is directly associated appears to be pretty good. It is reported that at Birkenhead Cammell's have enough work in sight to provide employment during the autumn and winter; while at Clydebank, Brown's are fairly busy.

The Lighter Side.

On the special and lighter sides of the steel industry, conditions continue comparatively good. Makers of special classes of steel have succeeded in maintaining deliveries at nearly the ordinary level, and the city is still in a position to execute orders for tramway trackwork, bright drawn steel, cold rolled material, and wire, as well as saws, files, and tools of many other descriptions. The melting of crucible steel is only partially suspended, and some of the blanks caused by the early days of the strike are now being filled up. That is due to German coke, the use of which has made it possible to restart certain furnaces which had been stopped for want of suitable fuel. The imported coke is expensive, but of good quality, and it has enabled some firms to produce qualities of steel, the supplies of which had run out. The home demand for engineering steel and tools is quieter, a shrinkage having been noticed for several weeks past.

Colliery Matters.

A somewhat serious situation appears to be developing in some of the deep pits in the Doncaster area as a result of the prolonged stoppage. I refer to overheating troubles, which have appeared in two or three cases, and have led to "gob stink," or even to the actual outbreak of gob fires. Last week, Mr. Herbert Smith, President of the Miners' Federation, visited both Bullcroft and Bentley collieries, and immediately after, authority was given for the employment of an increased number of safety men. At Bentley, the local branch of the miners' union agreed to the employment of no fewer than 600 men—200 on each shift—but the number actually engaged so far, is not so large as that. The activity in outcrop coal getting continues unabated, alike in Sheffield and in various neighbouring places, and considerable tonnages are being sent into the city for industrial and domestic purposes. At Manor Laith-road, in the Park district of Sheffield, where work was stopped by the police some time ago, a resumption has now been permitted, and from 30 to 50 tons are being raised daily. A 4ft. 6in. seam has been discovered in a field at Darnall. The Tinsley Park Colliery Company is the owner of the mineral rights, and it is understood that arrangements are being made for the working of the coal for industrial purposes. There are still full supplies of gas and electricity in Sheffield, and they are proving of great value to industrial as well as domestic consumers. In Rotherham, however, the difficulty of obtaining coal has led to a restriction of the gas supplies. For several weeks the pressure on the mains has been reduced, and now it is announced that a system of rationing is to be enforced, the hours during which gas will be available being 7 a.m. to 9 a.m., 11 a.m. to 1.30 p.m., 4.30 p.m. to 6 p.m., and 8.30 p.m. to 10.30 p.m.

Cutlery and Plate.

Conditions in these trades are perhaps on the whole somewhat less unsatisfactory than they have been. Some firms report that they are better employed than at any time since the beginning of the coal stoppage, and a revival appears to be developing in spoons and forks. One manufacturer, interviewed on the subject a few days ago, described the cutlery trade as "not bad, but far from good." There was an increased call for better-grade goods, he said, and a falling off in the demand for cheap stainless knives. Reports come from Germany of a slackness in the cutlery industry there, attributed in part to the dumping of French wares. The Sheffield trade is experiencing keen competition from the same source, and also from Belgium and Italy, all those countries being assisted by their low rate of exchange. The markets in which Sheffield is suffering are principally Scandinavia and South America. Considerable attention is just now being paid to the question of regaining the cutlery trade with the United States, which has fallen off to a great extent during recent years, owing to high tariffs. Much interest is being taken in a scheme of co-operative advertising, which a London publicity firm has submitted to the local trade. It is pointed out that America is the biggest potential buyer of high-class Sheffield cutlery, that its population of 110,000,000 contains a greater proportion of wealthy people than that of any other race, and that the determination of the rich class to possess the world's best in all commodities surmounts all tariff walls. One of the proposals is that a central show-room should be established in New York, in which would be displayed a representative range of Sheffield cutlery samples, and a visit to which would become a regular part of every cutlery buyer's itinerary when paying his buying visits to the city. A moderate expenditure on Press advertising in high-class periodicals is contemplated. It is further suggested that a particular mark shall be created, which shall appear on all Sheffield cutlery and plate, and shall be a guarantee of excellence, and that that design shall form the basis of all advertising. Another proposal is that the campaign shall be opened with a broadcast address on the Sheffield cutlery industry by some gentleman prominently identified with it. The scheme is now receiving the consideration of the Sheffield cutlery trade.

A Smokeless Furnace.

Leeds Corporation has recently installed at its public baths in Cookridge-street the Climax patent furnace, of which Mr. J. A. Hope is the inventor, the object of which is to effect a substantial economy in fuel cost without reduction of output, and to eliminate smoke. The coal is first gasified, and then, by means of a flame brought over the top of the fire by blasts of hot air, all the gases are ignited, and generate heat instead of being allowed to escape in fumes and smoke. A demonstration of the furnace was carried out last week, before representatives of Leeds Corporation and surrounding municipalities. The officials of the baths report that, according to their experience, the saving on fuel is from 10 to 15 per cent., and that the installation practically ensures the elimination of smoke.

NORTH OF ENGLAND.

(From our own Correspondent.)

A More Hopeful Feeling.

THERE is little change to report in the industrial position in the North of England this week, and business has ruled on quiet lines, but a more cheerful tone has prevailed. Traders are taking a brighter view of the situation, and are apparently becoming convinced that the next two or three weeks will see the coal dispute brought to a head, and that by the beginning of October coal supplies will again be normal. In the meantime increasing quantities of foreign coal are coming forward, and supplies in hand are now on such proportions that preparations are being made to restart idle plant in the iron and steel trades. Dorman, Long and Co., Ltd., are restarting at the Redcar Works next week three steel furnaces and one plate mill, while a second plate mill will be put into operation at the firm's Port Clarence Works.

Two Dock Schemes for Tees-side.

Important developments for improving the shipping facilities on the river Tees at Middlesbrough are foreshadowed. In busy times the present dock accommodation has been found to be inadequate, and there has been considerable congestion in the river, resulting in the delay of vessels and additional costs to shipowners. During the past two or three years a great scheme involving the expenditure of about three million pounds has been under examination for the construction of a new dock near the mouth of the river. That project secured powerful local backing, but its advocates failed to convince the London and North-Eastern Railway Company that any adequate return would be forthcoming for the huge expenditure involved, and, if not definitely abandoned, the scheme has on that account been shelved. The railway company has, however, been exploring the possibility of acquiring the Cleveland Dockyard, which has lain idle for over three years. Although official confirmation is withheld, it is understood that the deal is practically completed. This purchase, when finally ratified, will give the railway company possession of nearly the whole of the land flanking the north side of the present docks. There is, moreover, a possibility of a still larger site being acquired, and thus the way will be cleared for an extension of the docks which will meet all probable requirements for many years to come. Another important dock scheme is also likely to be launched in the near future. The development of the enterprise of Synthetic Ammonia and Nitrates, Ltd., of Billingham, has been so rapid that already the need of proper wharf or dock accommodation has been felt, and the

intention of the directors being to cultivate a world-wide trade in their products, they have had under consideration a scheme for the construction of a private dock on the company's land at Billingham. The company has a river frontage of over 1000ft. on the north side of the Tees, and plans have been prepared for the construction of a dock with three or four berths which, with the necessary sidings, &c., will cover an area of about four acres.

Cleveland Iron Trade.

Little that is new has happened this week in the Cleveland iron trade. Demand, already very limited, has further declined, owing to the annual holidays, but makers have so little material to offer that they can view any contraction with indifference. Now that there is some hope of an early termination of the coal dispute, makers and merchants are anxiously speculating as to trade prospects when the miners get back to work. It is realised that the major portion of the rest of this year's trade in pig iron has already been secured by continental competitors; but, nevertheless, an optimistic feeling prevails in the Cleveland district regarding future prospects, and a general opinion prevails that a settlement of the coal dispute will be followed by a rapid recovery, and a big expansion in home business. Cleveland pig iron prices remain steady and unchanged, No. 1 Cleveland foundry being 92s. 6d.; No. 3 G.M.B., 90s.; No. 4 foundry, 89s.; and No. 4 forge, 88s. 6d. per ton.

Hematite Pig Iron.

East Coast hematite pig iron tends towards higher values. It has, of course, been relatively cheap owing to the existence of stocks at the makers' works, but these stocks have now almost disappeared, and quotations have advanced by 1s. 6d. per ton, mixed numbers now being quoted at 82s. 6d., and No. 1 quality at 83s. per ton, although buyers claim that it is possible to purchase elsewhere at lower figures.

Manufactured Iron and Steel.

There is scarcely any business passing in the manufactured iron and steel trade owing to the lack of material. A fair amount of semi-finished steel is being imported, but the French and Belgian producers have not only put up the price, but in some cases have ceased altogether to book orders, and some of the sheet mills are urgently in need of bars. Prices are unaltered.

The Coal Trade.

The Northumberland and Durham miners are still sitting tight, and there are no special signs of any breakaway towards district settlements. Still the hope appears more pronounced that the deadlock is nearing the end, and that the last quarter of the year may not turn out so black as the outlook indicates. Shippers are now more inclined to communicate with their overseas customers, but at the same time cannot yet offer any definite prices or dates of shipment, and no transactions are seriously under consideration. Forward prices are likely to rule at firm values for the first week or two after the settlement, but after that period it is anticipated that they will recede to low figures, owing to the serious overseas competition. Speculators' ideas of coal values after a settlement are on the basis of 18s. per ton for best steams, but coalowners' ideas are much higher.

SCOTLAND.

(From our own Correspondent.)

General Situation.

WHILE there can be no direct improvement until the coal strike is settled, the situation is not without some slight encouragement in the nature of bookings, which will ensure a good restart when conditions are normal again, provided the cost of fuel is moderate. Further prolongation of the coal dispute may result in some cancellations, but in few instances has such action yet been taken. Further shipbuilding orders for Port-Glasgow are reported, and the yards in that district should be well employed when the strike is over. Rumours of cancellations of large contracts placed in Clydebank have been abroad, but nothing definite has been reported yet in this connection. The steel, iron and coal markets remain more or less idle.

Steel.

The only fresh item of news concerning the steel industry is the report of the restart of a steel re-rolling mill. The production of heavy steel continues almost at a standstill, and the shortage is seriously felt by shipbuilders and engineers alike. Black and galvanised sheets are in steady demand at enhanced prices, but makers are not at all anxious to book orders for early delivery in the meantime, with the rate of output reduced.

Iron.

The present modest production of bar iron and re-rolled steel meets a ready demand, and prices are now more or less a matter of arrangement, though nominally unchanged from week to week. Supplies of pig iron are reduced to a minimum, and are now very difficult to secure. Prices are firm, and still inclined to move upwards.

Prices.

Generally speaking, orders for steel and iron for delivery on the re-establishment of normal conditions are still being accepted at prices near the agreed minima. Continental prices are said to be appreciating, and local rates may possibly be somewhat advanced.

Coal: Outcrop Working.

For some time past there has been considerable activity at an outcrop seam in Larnarkshire, despite the efforts of the miners' leaders to stop these operations. Public works in the neighbourhood are reaping the benefit of such labours, and are thereby enabled to keep going.

Activity at Grangemouth Docks.

In order to cope with an abnormal rush of traffic, chiefly in coal and timber, the employers at Grangemouth dock asked the men to work an all-night shift. A meeting was held, when the men's representatives recommended the acceptation of the employers' terms, but it was only on the casting vote of the chairman that the recommendation was accepted. This arrangement overrides a local agreement recognised by the port's joint Labour Committee that no night work shall be done in Grangemouth.

Coal.

So far as the local conditions are concerned, there is little or no change. Numbers of miners have indicated their willingness to resume, but the number actually at work has shown only a small increase during the past week. Foreign coal is plentiful, but is not in great demand, apart from public utility concerns and household requirements, the price being too high to attract many commercial consumers. In many districts household fuel has been raised in price, and anywhere between 3s. 3d. to 4s., and perhaps over the latter figure, is charged per cwt., according to district.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Dispute Outlook.

ALTHOUGH there appears to be a brighter prospect of a resumption of negotiations in order to bring about an end to the present struggle in the coal industry, there will have to be a very different attitude on the part of one or other party, or probably both, if an agreement is to be reached quickly. When it comes to a question of the vital points at issue, it must be admitted that with all the talk of recent weeks practically no advance has been made towards a settlement. If the stand taken by some of the miners' leaders in this district is to be regarded seriously, then the strike might easily go on for another month or so; but the optimism which has lately become more pronounced that there will be an early termination to the stoppage rests not so much on the attitude of the miners' leaders in this district as the likelihood of a breakaway on the part of the miners in other areas. It would be no surprise if the South Wales miners were the last to resume work, and for this reason there is no expectation of work being begun in this coalfield this month, and it may be that there will be none before the middle of September. In any circumstances, it has to be remembered that even after the stoppage is declared off there will be a lot of repairing work to be done at most of the collieries, and it will take a fortnight practically to obtain anything like an output.

Prospects of Business.

The slightest indication of an improvement in the outlook has, of course, brought with it a marking up of coal and iron shares on the stock markets; but in view of the heavy losses which the strike has inflicted upon all undertakings, it is difficult to see how share values can advance very far. An occasional inquiry has been received for supplies of coal, but at the moment colliery companies and coal exporters are not entertaining business for shipment when the stoppage is over. In the first place colliery companies have not formulated any definite prices, for the reason that they cannot as yet tell what their costs of production will be until the terms of settlement are arranged, and coal exporters cannot obtain quotations as a consequence, while, in addition, they have the further difficulty of arriving at a definite idea as to what freight rates are likely to be. It is not surprising, therefore, that they are holding their hands for the moment. It is likely to take some time for business to settle down under the best of circumstances, and in view of the heavy shipments of foreign coal to the markets formerly served by coals from this country, it is impossible to form any reliable estimate as to what the demand is likely to be. American coals will arrive in this country until as late as October, as tonnage has been chartered running to the end of September, and it is known that foreign buyers have entered into contracts for supplies of continental coals practically to the end of the year. The stoppage of work in this country has, of course, sadly interfered with the delivery of anthracite coals to Canada, inasmuch as cargoes have to be got away from this district by about the middle of November, and in the short time available it will be impossible to make up the ground that has been lost since May 1st.

Coal Imports.

Activity at South Wales docks has been chiefly in the discharge of imported coals during the past few weeks. New business has, of course, slackened off of late in view of the possible developments in the coal position generally; but at the same time numerous cargoes have recently come to hand from America and from the Continent. Altogether the quantity of imported coal discharged at South Wales ports from the beginning of May runs now to round about half a million tons, and there is a good deal more to come. Imports of timber have been fairly well maintained, but other commodities have fallen off to a considerable extent of late.

Craftsmen's Agreement.

Towards the end of last week an important agreement was signed by the South Wales Coalowners and the Executive Committee of the South Wales and Monmouthshire Association of Colliery Enginemen, Boilermen and Craftsmen. This agreement is based on an eight-hours' day and embodies practically the terms which were offered by the coalowners immediately following upon the removal of the statutory limitation of a seven-hour working day. The craftsmen's organisation has always been recognised by the coalowners, but this agreement practically places it on the same level as the South Wales Miners' Federation, as very similar machinery is set up for dealing with disputes and all matters arising between the parties. A joint Committee is established of fifteen from each side. The South Wales' Miners' Federation has always been antagonistic to the Craftsmen's organisation, and the action on the part of the latter organisation in coming to the agreement now concluded is bitterly resented by the Miners' Federation, whose Executive Committee on the following day—Friday—passed a resolution that instructions should be sent to every lodge that under no circumstances were any of the workers in the grade of enginemen, boilerman or craftsmen who are members of the Federation, to accept such terms of employment, and if any attempt was made to inflict them upon the safety men now working they must at once withdraw their labour.

Permission to Work Refused.

A deputation representing the workmen employed at the Blackbrook Colliery, Caerphilly, met the central executive of the South Wales Miners' Federation at Cardiff on Friday last, for the purpose of asking permission to resume work on terms offered by the colliery, viz., those which existed before the stoppage. It is understood that the colliery has large development schemes in contemplation, and it was desired that work should be resumed immediately so that these schemes could be carried on without delay. The central executive decided against the application.

Steel and Tin-plate Works.

Now that the supply of foreign coal has increased there is more activity at steel and tin-plate works. An extra number of tin-plate mills are operating, and it is reported that altogether the output is up to at least 30 per cent. of the normal. Now that production is on a slightly increased scale and with business rather less active, the tone of the market is not so firm. Stock plates are offered from 21s. 6d. to 24s. 6d. basis I.C., f.o.b. works ports, while for plates for shipment after the coal stoppage sellers are asking up to 22s.

Strike at Swansea Docks.

On Friday last locomotive men employed at Swansea Docks came out on strike because the company would not undertake to call out the same number of engines on the Saturday as on the Friday morning. The men's action caused a certain amount of loss and inconvenience, but the strike is fizzling out, as about half the men returned to duty almost immediately.

LATER.

An official statement issued by the Great Western Railway Company states that the locomotive men and shunters who struck work at Swansea docks on Friday last, in contravention of agreement, will not be re-employed. Despite the action of the men concerned, work has been carried on much as usual, though apart from the loss and inconvenience caused, certain vessels which were to be discharged at Swansea have been diverted to other ports.

Conditions of Employment at Docks.

The operation of the reduction in the trimming tariff, which was to come into force on the 16th inst., has been deferred. The local secretary of the Shipping Federation has notified all shipowners that it has been decided that from September 1st those who desire to make their own choice of dock pilot at Cardiff can do so independent of the rota system, which has been in operation for some time past. There is also evidence that many coal trimmers are tired of the present conditions of employment, by which their earnings are pooled, and some of them have already intimated their willingness to go back to the system under which they were engaged directly by leading coal shippers.

CATALOGUES.

HANS RENOLD, Ltd., Didsbury, Manchester.—Latest price-list of chains for industrial applications.

GENT AND CO., Ltd., Faraday Works, Leicester.—"Bell indicator and accessories catalogue—Book I."

J. P. HALL AND CO., Ltd., Werneth, Oldham.—List No. 60 of the patent centrifugal speed limiting brakes.

CHAS. CHURCHILL AND CO., Ltd., 9, Leonard-street, E.C. 2.—Leaflet describing the "Interlox" master slide rule.

G. H. SCHOLES AND CO., Ltd., Blantyre-street, Chester-road, Manchester.—Leaflet describing the "Wylex" two-piece gland.

PARSONS MOTOR COMPANY, Ltd., Town Quay Works, Southampton.—Publication No. 83, dealing with "Parsons" gas-oil engines.

RYLANDS BROTHERS, Ltd., Warrington.—Booklet giving a detailed description of the manufacture, use, and results obtainable from "Rylax" welding wire.

J. PICKLES AND SON (ENGINEERS), Ltd., Hebden Bridge.—Catalogue illustrating and describing the latest types of woodworking machinery being constructed by the firm.

PREMIER COOLER AND ENGINEERING COMPANY, Ltd., Shalford, near Guildford.—Catalogue illustrating several water-cooling plants designed and erected by the company.

THE ELECTRIC CONSTRUCTION COMPANY, Ltd., Ingersoll House, 9, Kingsway, W.C. 2.—Catalogue B. 626, dealing with rotary converters; and sheet S. 762, a specification of E.C.C. electromagnets.

HARVIE CORPORATION, Ltd., Broadway Buildings, Westminster, S.W. 1.—Brochure relating to the portable belt conveyor manufactured by the Austin Manufacturing Company, Chicago, U.S.A.

MARSHALL, SONS AND CO., Ltd., Britannia Ironworks, Gainsborough.—Publication No. 1537, briefly describing the "Marshall" locomobile engine, the boilers of which can be fitted with special fire-boxes and grates to burn waste combustibles of low calorific value, such as sawdust, bark, rice husks, &c.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—New publications: D.S. 3312-1, truck type ironclad switchgear; price list No. 5352-A, D.C. motor control pillars with drum starters; price list No. 5351-B, D.C. motor control pillars with face plate starting switch; price list No. 7201-C, fractional H.P. motors for A.C. and D.C. circuits.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 2 6	—
No. 1 Foundry	4 10 0 to 4 15 0	
No. 3 Foundry	4 5 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 2 6	4 2 6
No. 1	4 3 0	4 3 0
Cleveland—		
No. 1	4 12 6	4 13 0
Silicious Iron	4 12 6	4 13 0
No. 3 G.M.B.	4 10 0	4 10 6
No. 4 Foundry	4 9 0	4 9 6
No. 4 Forge	4 8 6	4 9 0
Mottled	4 8 0	4 8 6
White	4 8 0	4 8 6
Mid.-lands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	(*None offered.*)	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	(*None offered.*)	
No. 3 Foundry	3 5 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 6 (*a*) / 4 12 0 (*b*) / 4 16 0 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. Coast—		
Common Bars	11 5 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. Yorks.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
Midlands—	(*Prices nominal.*)	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	— £17 5 0 to £18 5 0	

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 10 10 0†	
Manchester—		
Bars (Round)	9 5 0	—
,, (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
,, (Soft Steel)	10 15 0	10 15 0
Plates	8 2 6	—
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	17 0 0 to 17 10 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	20/- to 24/6
Block Tin (cash)	291 0 0
,, (three months)	285 15 0
Copper (cash)	59 2 6
,, (three months)	59 7 6
Spanish Lead (cash)	32 12 6
,, (three months)	32 5 0
Spelter (cash)	34 3 9
,, (three months)	34 12 6
Manchester—	
Copper, Best Selected Ingots	66 17 6
,, Electrolytic	67 17 6
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	34 12 6
,, Foreign	32 15 0
Spelter	34 17 6

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£20 15 0	6/6
,, Specially Refined		
,, Max. 2 p.c. carbon	£38 10 0	12/6
,, ,, 1 p.c. ,,	£44 10 0	15/-
,, ,, 0·70 p.c. carbon	£54 10 0	17/6
,, ,, carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£10 17 6 scale 5/- per unit	
,, ,, 75 p.c.	£20 10 0 scale 6/- per unit	
,, Vanadium	15/- per lb.	
,, Molybdenum	5/9 per lb.	
,, Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

	(*Prices nominal.*)	Export.
Lanarkshire—		
(f.o.b. Glasgow)—	Steam	15/9
,, ,,	Ell	16/6
,, ,,	Splint	16/6 to 17/-
,, ,,	Trebles	15/9
,, ,,	Doubles	14/- to 14/6
,, ,,	Singles	13/9
Ayrshire—		
(f.o.b. Ports)—	Steam	16/9
,,	Jewel	17/- to 17/6
,, ,,	Trebles	17/-
Fifeshire—		
(f.o.b. Methil or Burntisland)—	Steam	12/6 to 14/9
Screened Navigation		21/-
Trebles		14/- to 15/-
Doubles		14/-
Singles		13/- to 13/6
Lothians		
(f.o.b. Leith)—	Best Steam	14/- to 14/3
Secondary Steam		13/6
Trebles		14/6 to 14/9
Doubles		13/6
Singles		13/6

ENGLAND.

(8) N.W. Coast—		
Steams		*No quotation*
Household		,, ,,
Coke		,, ,,
Northumberland—		
Best Steams		16/-
Second Steams		14/6 to 15/-
Steam Smalls		8/- to 8/6
Unscreened		13/- to 13/6
Household		20/- to 22/-
Durham—		
Best Gas		18/6 to 19/-
Second		15/- to 15/6
Household		20/- to 22/-
Foundry Coke		18/- to 20/-
Sheffield	Inland. (*Nominal: none on offer.*)	
Best Hand-picked Branch	31/- to 34/-	—
Barnsley Best Silkstone	28/- to 30/-	—
Derbyshire Best Brights	26/- to 28/-	—
,, ,, House	24/- to 25/-	—
,, ,, Large Nuts	17/- to 20/-	—
,, ,, Small	12/6 to 14/-	—
Yorkshire Hards	17/- to 19/6	—
Derbyshire Hards	16/- to 19/-	—
Rough Slacks	10/- to 12/6	—
Nutty Slacks	7/6 to 9/-	—
Smalls	3/6 to 6/-	—
Blast-furnace Coke (Inland)*	—	—
,, ,, (Export)	f.o.b.	16/- to 17/

(9) SOUTH WALES.

(*All prices nominal.*)

Cardiff—	
Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second ,, ,,	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary ,, ,,	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary ,,	16/- to 17/-
Washed Nuts	19/- to 20/-
No. 3 Rhondda Large	26/6 to 27/-
,, ,, Smalls	18/- to 18/6
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 21/-
,, ,, Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
Swansea—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Coal.

The failure to carry through the twenty-four hours' strike in the French collieries should convince British miners that they can expect nothing from their French colleagues, not even their sympathetic support. As the result of the stoppage of British supplies of coal, the French colliery industry is in an exceptionally prosperous condition, and there can be no question of momentarily interrupting the general activity. It was feared at one time that the export of coal to England, in place of the large quantities that were formerly imported, would have had the effect of reducing home supplies and of inflating prices, but it is declared that those fears were not justified, for in May and June the exports of coal to England amounted to only 43,000 tons. The exports to Belgium were a little above the average, but they were more than made up for by the larger consignments of coal from that country. On the whole, the stoppage of British coal supplies would be scarcely observable in France if it were not for the unfortunate situation of Rouen, and it fits in perfectly with the scheme of the Government, which has long been endeavouring to replace British coal with fuel from the Saar and the Ruhr. Every encouragement is, in fact, given to the importation of German coal, which has now secured such a hold on the French market that it will be difficult for British coalowners to displace it, except in the case of anthracite and best steam coals. Business in future will have to be done in face of exceptionally severe competition which has been fostered by the strike. That alone represents a huge loss which will have to be borne partly by the miners. Meanwhile, the Government has found it necessary, in the interests of home consumers, to prohibit the exportation of coal to England. In view of the general activity at the collieries the French miners have appealed for an adjustment of wages, which has been in abeyance for a considerable time. So long as the coalowners were able to show that they were making no profits the question of wages was allowed to stand over until something could be done to improve the situation of the industry. At the same time living costs have been steadily increasing, and the coalowners have therefore agreed to advance wages on the understanding that the agreement may be revoked at any time on giving a month's notice. That step is intended to protect the coalowners from any failure of the Government to carry out its promise to assist them in securing profitable prices for their coal. The official policy is to get the price of coal down as low as possible and to insure adequate supplies by organising an ample importation from the Ruhr, and that must be done without affecting the interests of French coalowners.

The Steel Union.

The meeting which was to have taken place at Dusseldorf to settle the final details of the European Steel Union was transferred to Paris, where it was held at the headquarters of the Comité des Forges. All reference to metallurgical products was left out of the Franco-German temporary commercial treaty because the matter was to be dealt with during the negotiations for the Steel Union, and it therefore follows that the Union must be definitely constituted if the treaty is to have any practical effect. At the Paris meeting the quantity of steel which may be imported into Germany from Lorraine and Luxemburg, as well as the conditions under which French, German, Belgian and Luxemburg steel makers are to limit production and participate in the foreign trade, were under consideration. There are still some details to be settled, but as they are regarded as of minor importance, it is confidently believed that the agreement will be signed at an early date. Consumers are naturally looking to this new combination with qualified satisfaction, for it will have the inevitable effect of raising prices; but, on the other hand, it is quite impossible for the steel trade to remain in its present condition.

German Imports.

The temporary treaty which has been signed with Germany gives to that country the most favoured nation treatment so far as concerns a large number of engineering products, and for others there is a considerable reduction in the existing special duties, which now lose their prohibitive character. These advantages are conferred in return for facilities granted by Germany for the importation into that country of agricultural and other produce. Reductions of 60 to 80 per cent. are made in the case of steam engines, traction engines and road rollers, as well as of certain classes of textile machinery. Papermaking machinery supplied for a factory now being laid down in France is admitted under the minimum tariff. The same favour is also accorded to all kinds of agricultural machinery and also to machine tools. For a period of six months Germany is placed practically on the same footing as other countries on condition that negotiations are resumed at once for the preparation of a permanent treaty.

A National Fuel.

Active propaganda work continues to be carried out in favour of employing suction gas for motor vehicles, and for some time past a motor omnibus has been running on that fuel through France, visiting all the towns where the question of substituting a "national fuel" for petrol is likely to offer public interest. Demonstrations with a similar omnibus have also been made in the neighbourhood of Paris in the presence of members of scientific and technical bodies and of engineers from the public transport companies. For a journey of 50 kiloms. the consumption is said to have been 60 kilos. of wood and 5 litres of petrol, which were used for starting up. It is affirmed that the employment of wood offers no drawbacks with the types of scrubbers now adapted to the plants, but it is obvious that if suction gas is to come into more general use it can only be with the aid of charcoal, which must be produced in larger quantities and more cheaply than at present. Notwithstanding the efforts that are being made to encourage the design and manufacture of portable carbonising apparatus, it does not appear as if the results, although encouraging, were entirely satisfactory.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

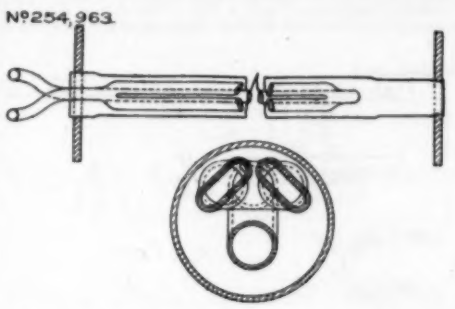
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

254,963. November 26th, 1925.—Superheaters, The Superheater Company, Limited, and H. E. Geer, 195, Strand, London, W.C. 2.

This superheater is of the type in which the superheating tubes are arranged inside the smoke tubes of the boiler. The steam flows in one direction, contrary to the direction of the hot gases,

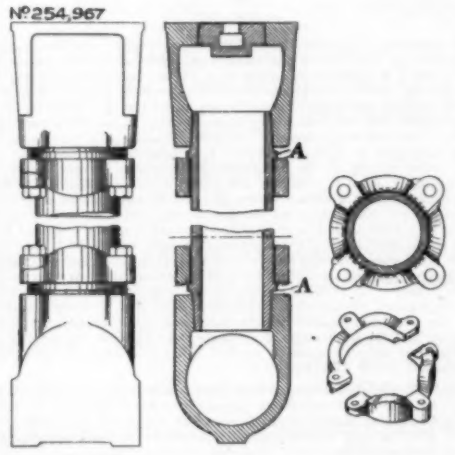


in two small flattened tubes and returns in a single round tube. By adopting this arrangement the flattened tubes can be placed in the hot upper part of the smoke tube and the return tube snugged in between them. Space is also left for cleaning out soot.—*July 15th*, 1926.

CONDENSERS AND FEED-WATER HEATERS.

254,967. March 10th, 1926.—Economisers, P. W. Goodbrand, Britannia Foundry, Stalybridge.

This invention is concerned with the fixture of economiser tubes in their headers. The tubes are cast with projecting collars A A and are held to the headers by split collars and

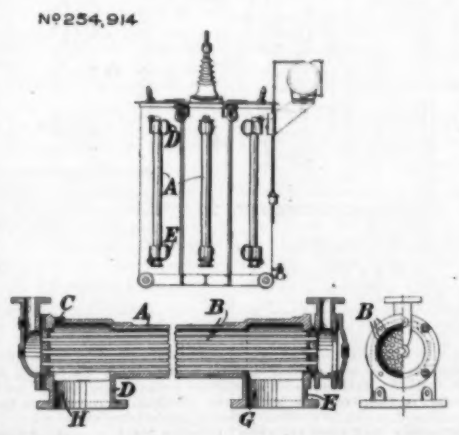


studs, as shown. The peculiarity lies in the formation of the collars, which are scarphed at the stud holes, so that one pair of the studs holds the two halves of the collar together.—*July 15th*, 1926.

TRANSFORMERS AND CONVERTERS.

254,914. September 22nd, 1925.—Improvements in or relating to Oil-cooled Electric Transformers, The British Electric Transformer Company, Ltd., of Hayes, Middlesex, and Jan Roothaan, of the same address.

When the transformer is in operation heated oil within the casing flows freely through the tubes A and is quickly cooled

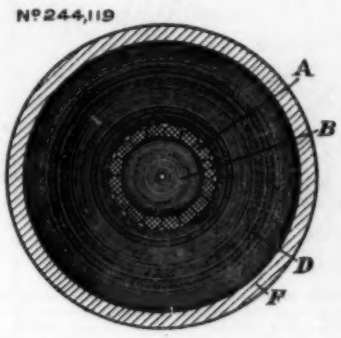


by contact with the ducts B, in which cooling fluid is caused to flow in an upward direction. Each of the tubes A may be provided with a hole C for the reception of an air cock and each of the branches D and E with holes G H for the reception of a thermometer.—*July 15th*, 1926.

TRANSMISSION OF POWER.

244,119. December 4th, 1925.—Improvements in and relating to Stranded Electric Conductors for High-tension Cables, Felten and Guilleaume Carlswerk Actien-Gesellschaft, of Köln-Mülheim, Germany.

In high-tension cables having very thick insulation the diameter of the conductor must not be less than a certain value if the strength of the electric field on the surface of the conductor is to remain below the limit set by the liability to puncture. According to this invention, the core of the hollow stranded conductor is made by paper strip being wound helically in layers under tension, similarly to the manufacture of the layered paper insulation of high-tension cables, so that a closely packed cylindrical paper body is formed. In order to facilitate the start of the winding operation the paper strip may be wound over a solid core consisting of a cord, a wire or a wire strand.

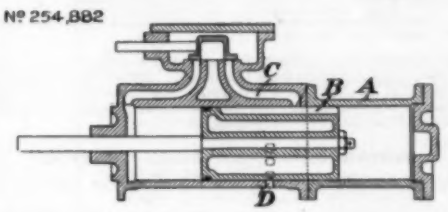


During the impregnation of the cable the interior of the hollow stranded conductor, which is formed by a layered paper cylinder with or without a separate core, is impregnated with filling. Owing to the close packing of the layers of paper wound on under tension there is no room in a core of hollow stranded conductors made in this way for the formation of air or vacuum spaces. When the core is formed on a wire or a wire strand the latter can also be used for conducting the current. It may also be used as a testing wire or as an auxiliary conductor for cable protecting systems. The accompanying drawing represents a single conductor cable without central wire. A is the conductor, B the core of paper strip wound tightly in layers, D the insulation of the conductors, and F the lead covering. There are three other illustrations showing single and triple-conductor cables with a central wire.—*July 15th*, 1926.

MINING MACHINERY.

254,882. July 16th, 1925.—Double-acting Air Engines, C. T. Barclay, 63, Portland-road, Kilmarnock.

This invention provides for the conversion of double-acting compressed air engines such as those used for driving mining machinery so as to provide auxiliary exhaust ports controlled by the main piston. For this purpose the normal cylinder casting is

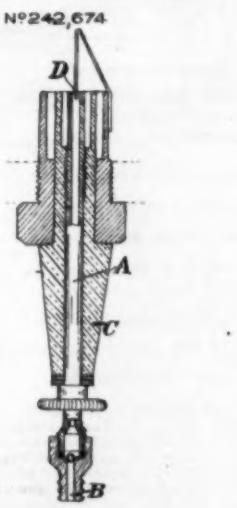


extended by a new piece A and a special long piston is adopted. This piston is provided with a passage B so that the port C is always in communication with the right-hand end of the cylinder and auxiliary exhaust ports are cut midway along the length of the extended cylinder at D. They do not, of course, extend circumferentially so far as the passage B.—*July 15th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

242,674. November 9th, 1925.—Method of and Means for Producing Blow-pipe Flames, Josef Modl and Karl Modl, both of Traunkirchen, Upper Austria.

The flame produced in accordance with this invention is adaptable for use in connection with the cutting and welding of metals, and more particularly for igniting the fuel mixture in

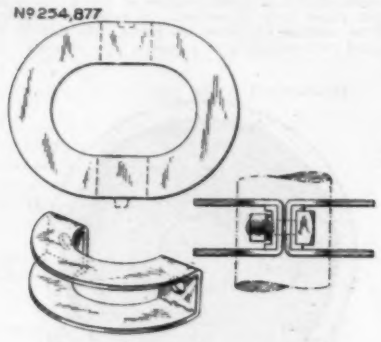


internal combustion engines, as it brings about a quick and exactly timed ignition. A sparking plug adapted for ignition in accordance with the invention is illustrated. The inner elec-

trode A is of tubular shape and is fitted at its outer end with a nipple B whereby it can be connected by means of a flexible pipe to a receptacle supplying air under pressure. The electrode A is spaced in the usual manner by insulation C from the outer casing which holds the second electrode. The latter consists of a wire which is bent back so that its free end D can be introduced a short distance into the bore of the electrode A. As the sparks occur between the wire D and the tube they are extended by the air blast so as to form a blow-pipe flame, and even very weak fuel mixtures will be promptly ignited.—*July 15th*, 1926.

254,877. July 7th, 1925.—SPLIT COLLARS, V. A. Trier, 36, Victoria-street, London, S.W. 1.

According to this invention, each half of a split set collar is formed by stamping an approximately oval-shaped ring out of sheet metal and afterwards bending this ring up in two

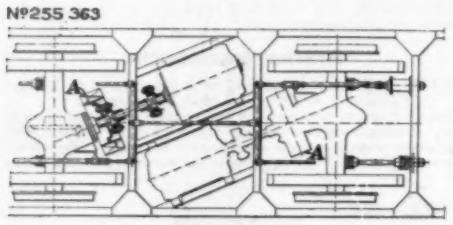


parallel planes to form a semi-circular channel-shaped member. The longer sides of the oval ring form the end faces of the semi-circular channelled member which can engage similar end faces of a correspondingly formed half ring and these two halves can then be secured together by means of bolts or screws in the usual manner.—*July 15th*, 1926.

TRAMWAYS AND RAILWAYS.

255,363. March 3rd, 1926.—ELECTRICALLY DRIVEN BOGIES, Société de Construction et d'Entretien de Materiel Industriel et Agricole Scemia, 9, rue Tronchet, Paris.

Compactness is the essence of this invention. In the specification it is pointed out that a compact arrangement of electric drive can be arranged with two motors alongside one another and parallel with the length of the truck. In such a case, how-

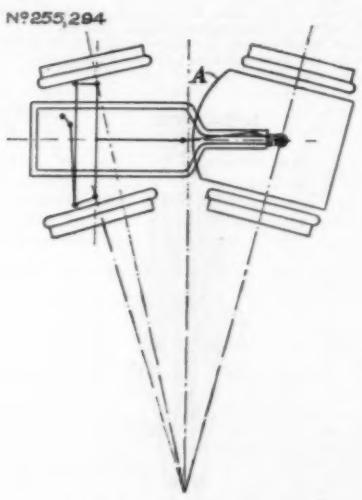


ever, brake drums cannot be accommodated on the motor shafts as they approach the wheels too closely. By setting the motors diagonally, as shown in the drawing, the gear-boxes can then be set on the centre line, and there is ample accommodation for the brake drums A A.—*July 22nd*, 1926.

MOTOR CARS AND ROAD TRAFFIC.

255,294. November 30th, 1925.—FOUR-WHEEL DRIVES, G. Fornaca, 7, Via Giannone, Turin, Italy.

This invention aims at the elimination of the third differential gear generally necessary in a vehicle having two pairs of driving wheels. For this purpose it is sufficient to arrange that at any time while the vehicle is describing a curve, the extensions of the axes of all four wheels meet on the middle line perpendicular to the segment connecting the centres of the two axles, thus ensuring that the back wheels will follow in the same track as the fore wheels when the vehicle is turning. For this purpose the rear axle is mounted on a turntable and is steered in accordance with the front axle by means of a pinion meshing with the quadrant A, so that the desired tracking is effected. It is pointed

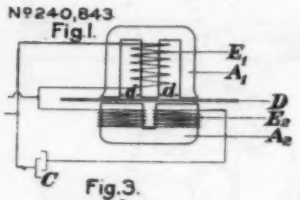


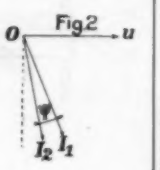
out that when the vehicle has to run on roads with turns of a sufficiently ample radius, as is the case on ordinary roads, the steering for the rear axle may be rendered inoperative by providing a clutch between the steering wheel and the pinion. In this case the steering action of the fore wheels is sufficient, the centres of the two axles undergoing an equal displacement. It is advantageous, it is said, to eliminate steering of the rear wheels whenever that is possible because a greater driving stability is thereby conferred to the vehicle which then runs like a single-frame vehicle. Stability is, of course, all the more necessary when the vehicle is running at a high speed, as is the case on ordinary roads with large curves.—*July 22nd*, 1926.

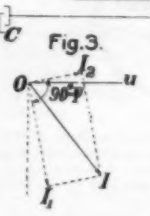
MISCELLANEOUS.

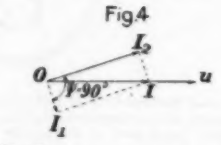
240,843. September 30th, 1925.—ALTERNATING-CURRENT RELAY, Compagnie pour la Fabrication des Compteurs et Matériel d'Usines à Gaz, of 12, Place des Etats-Unis, Montrouge (Seine), France.

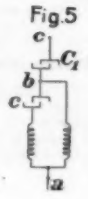
The object of this invention is to provide an improved device adapted to operate as a relay in which the torque is maximum for a given frequency and decreases rapidly on either side of this frequency, and particularly adapted to high frequencies. It has been proposed, in the case of induction relays of the type referred to, to connect the condenser to a secondary winding of the electro-magnet, that being equivalent to a condenser connected in parallel with the primary of the electro-magnet. According to the invention, a relay of the type described is used, in which the condenser is connected in series with the primary of the electro-magnet, the two windings of which are connected in parallel, so as to obtain a phase difference of nearly 90 deg. in the windings. An additional condenser may be connected in series with the two circuits, the capacities and self-inductances being adjusted so as to have the greatest possible ratio between the voltage of the terminals of the derived circuits and that of the supply. The relay consists of two electro-magnets A_1 and A_2, excited respectively by two windings E_1 and E_2, connected in parallel, these electro-magnets acting, as in the arrangement of an induction wattmeter, upon a disc D movable in their gap. A capacity C is connected in series with one of the windings E_2







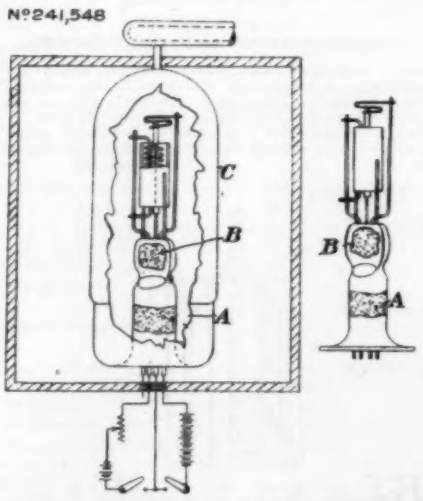




for obtaining a suitable phase difference ψ (Fig. 2). As the couple exerted on the disc is practically proportional to the product $I_1 I_2 \sin \psi$ it is preferable that $\sin \psi$ should be equal to unity or near that value, in order to obtain the greatest possible torque. The magnet winding E_2, which is not connected in series with the condenser, can be given sufficient inductance to cause the current I_2 to be almost in quadrature with the voltage u (Fig. 3). Matters are arranged so that the current I_2 is sensibly in phase with u in order to utilise the condition of resonance in the magnet winding E_2 so as to obtain a maximum number of ampère turns in that winding with a selected phase difference at the selected frequency. The constants of the circuits can also be adjusted (see Fig. 4) in such a way that the current I_1 is out of phase by an angle such that, for determined relative values of I_1 and I_2, the resultant I of the currents I_1 and I_2 is in phase with the voltage u, the phase difference ψ being equal to 90 deg. or near this value. By putting a capacity C_1 (Fig. 5) in series with the arrangement described in connection with Fig. 1 the reactance of the relay can be also greatly decreased and even be annulled, which has the advantage of rendering the ratio of the potential difference between a and b to that between a and c as great as possible.—*July 15th*, 1926.

241,548. October 10th, 1925.—IMPROVEMENTS IN OR RELATING TO THE EXHAUSTION OF CLOSED CONTAINERS SUCH AS ARE USED FOR THERMIONIC DISCHARGE DEVICES, *Westinghouse Electric and Manufacturing Company, of East Pittsburgh, Pennsylvania, United States of America.*

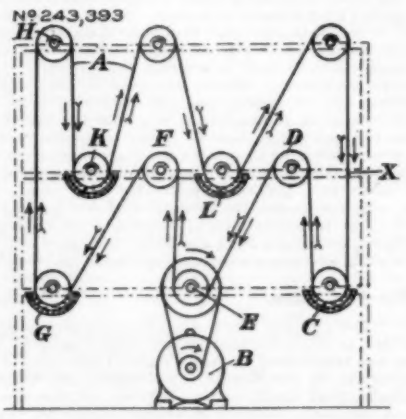
This invention relates to the exhaustion of closed containers such as are used for thermionic discharge devices, and particu-



larly to means for producing and maintaining a suitable vacuum therein. It is well known that by heating such compounds as the formate, oxalate, acetate or other organic acid salt of such metals as iron cobalt or nickel the metal is liberated from the compound in the form of very finely divided free metal which is chemically very reactive. The liberation reaction which occurs very readily at a low vapour pressure with slightly elevated temperature results in the formation of a finely divided free metal and the liberation of the organic acid portion of the compound in a volatile form as carbon dioxide or as mixtures of carbon dioxide, carbon monoxide, water, &c. According to this invention, a mixture is produced consisting of an organic acid compound of some one of the metals mentioned, with a similar organic acid compound of magnesium or similar metals or with some convenient compound of calcium, such as lime, to which mixture magnesium may be added also as a compound. This mixture is combined with water to form a paste, which is then spread upon the mount of the discharge device as shown at A in the drawing. If desired, the lime absorbent may be spread upon another portion of the mount, as shown at B in the drawing. The mount may then be assembled within the container C and the interior of the device may be connected by the customary tube to a vacuum pump and provision made for heating and partially exhausting the device. The operation of baking and exhausting simultaneously, reduces the vapour pressure within the device and also causes the chemical reaction to occur, whereby the pyrophoric metal is liberated within the device and the lime and magnesium compounds prepared for their functions. The device may then be sealed off from the pump. After standing a short time the pyrophoric metal removes a large portion of the residual gases which may not have been removed by the pump. By this means it is possible to evacuate the device roughly upon the pump and to depend upon the pyrophoric metal to complete the evacuation and the reduction of the pressure within the device to the value required for satisfactory operation. In this way it is possible to simplify the operations required in the evacuation of a thermionic discharge device and thereby to cheapen the cost of manufacture and to facilitate the production of better devices of this character.—*July 15th*, 1926.

243,393. November 24th, 1925.—IMPROVEMENTS IN METHOD AND MEANS FOR METALLISING INSULATING BANDS PARTICULARLY FOR USE IN ELECTRIC CONDENSERS, *Dubilier Condenser Company* (1925), *Ltd., of Ducon Works, Victoria-road, North Acton, London, W.* 3.

This invention relates to a method of and means for metallising the surfaces of insulating bands, particularly for use in electric condensers. An endless band of insulating material A is driven by a motor B in the direction of the arrows from the point X through the metallic salt solution contained in first bath C, thence by way of supporting roller D, driving drum E, and supporting roller F to the first reducing agent contained in bath G.



With the passage of the band over supporting roller H down to the second metallic solution bath at roller K the outer surface passing around this latter roller becomes reversed. The band continues in this manner through the second reducing bath L and returns to the starting point X. Thus in one complete cycle of operation each side of the band becomes the outer surface when passing through the independent baths containing the metallic salt solution and the reducing agent. This operation may, of course, be repeated any number of times to obtain the desired metallic coating on the insulating band. An alternative arrangement is described.—*July 15th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

SATURDAY, AUGUST 21ST.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—Newcastle-upon-Tyne. Annual general meeting. 2.30 p.m.

FRIDAY AND SATURDAY, AUGUST 27TH AND 28TH.

IRON AND STEEL INSTITUTE.—Autumn meeting at Stockholm. For programme see page 125.

WEDNESDAY TO SATURDAY, SEPTEMBER 1ST TO 4TH.

INSTITUTE OF METALS.—Autumn meeting at Liége. For programme, see pages 45 and 181.

TUESDAY TO THURSDAY, SEPTEMBER 14TH TO 16TH.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS.—Annual meeting and Conference at Newcastle-upon-Tyne.

CORNWALL WORKS, BIRMINGHAM.—To all students of the history of engineering, a little brochure recently issued by Tangyes Ltd., of Birmingham, will be of much interest. It is called a "Brief History of Cornwall Works," and although much of the material it contains is fairly generally known, it is put forward in a concise and easily read form. The growth of the Cornwall Works has, of course, coincided with practically the whole of mechanical engineering industry in England and, for the matter of that, in the world. The first member of the Tangye family who displayed any marked aptitude for engineering was born at St. Columb, in Cornwall, in 1776, but it was not until 1852 that Richard Tangye started work in Birmingham. From that time right up to the present there has been a steady advancement in the business of the firm from a start in a workshop rented at 10s. a week, until in immediate pre-war days the number of employees totalled nearly 3000.